JPRS 78461

7 July 1981

West Europe Report

SCIENCE AND TECHNOLOGY

No. 66

FBIS FOREIGN BROADCAST INFORMATION SERVICE

NOTE

JPRS publications contain information primarily from foreign newspapers, periodicals and books, but also from news agency transmissions and broadcasts. Materials from foreign-language sources are translated; those from English-language sources are transcribed or reprinted, with the original phrasing and other characteristics retained.

Headlines, editorial reports, and material enclosed in brackets [] are supplied by JPRS. Processing indicators such as [Text] or [Excerpt] in the first line of each item, or following the last line of a brief, indicate how the original information was processed. Where no processing indicator is given, the information was summarized or extracted.

Unfamiliar names rendered phonetically or transliterated are enclosed in parentheses. Words or names preceded by a question mark and enclosed in parentheses were not clear in the original but have been supplied as appropriate in context. Other unattributed parenthetical notes within the body of an item originate with the source. Times within items are as given by source.

The contents of this publication in no way represent the policies, views or attitudes of the U.S. Government.

PROCUREMENT OF PUBLICATIONS

JPRS publications may be ordered from the National Technical Information Service, Springfield, Virginia 22161. In ordering, it is recommended that the JPRS number, title, date and author, if applicable, of publication be cited.

Current JPRS publications are announced in Government Reports Announcements issued semi-monthly by the National Technical Information Service, and are listed in the Monthly Catalog of U.S. Government Publications issued by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Indexes to this report (by keyword, author, personal names, title and series) are available from Bell & Howell, Old Mansfield Road, Wooster, Ohio 44691.

Correspondence pertaining to matters other than procurement may be addressed to Joint Publications Research Service, 1000 North Glebe Road, Arlington, Virginia 22201.

JPRS 78461

7 July 1981

WEST EUROPE REPORT

SCIENCE AND TECHNOLOGY

No. 66

CONTENTS

SCIENCE POLICY

TRANSPORTATION

Briefs

BIOTECHNOLOGY

ICI OFFICIALS INTERVIEWED ON UNICELLULAR FODDER ORGANISM

Paris INFORMATIONS CHIMIE in French Apr 81 pp 173-177

[Interview with Ian Beatty, ICI, commercial manager for Pruteen, and Michel Maisonnial, spokesman from the Agriculture Service of ICI France, at the Agriculture Show, date not given; questions and answers in French: "Proteins from Unicellular Organisms. A world first for ICI"]

[Text] The use of continuous fermentation to obtain unicellular organisms capable of being used in animal nutrition as a replacement for natural products such as fish meal and soybean meal constitutes one of the promising aspects of biotechnology. Numerous advances have been made in this field the last 10 years, particularly under the leadership of a BP [British Petroleum Corporation group which did pioneering work in the industrial development of fermentations on hydrocarbons. As we know, this technical success did not achieve the commercial success it would deserve, and the units built in France (Lavera) and especially in Italy (Italprotein in Sardinia) were finally shut down some years ago. In effect, the rapid increase in petroleum prices no longer allows proteins based on that raw material to compete with the natural products. But another variant, involving the use of methanol as a carbon and energy source for the fermentation, has been studied; through the efforts of ICI [Imperial Chemical Industries Limited] this approach has now led to an initial industrial installation. Compared to hydrocarbons of petroleum origin, methanol actually exhibits a threefold advantage: it is capable of being manufactured from natural gas or coal, so its price is not linked in a direct way to the price of crude; it does not leave hydrocarbon residues in the proteins; and it is miscible with water, so it permits simpler fermentation technology. It was natural that the group from ICI, number one in the world for methanol production, would, with this new technique, take up the challenge of producing unicellular proteins, seeing that the process could represent an important outlet for ICI's production output. The British group holds a commanding position with the production technology by virtue of their low-pressure process and their catalysts as well as with the economics, thanks to long-running procurement contracts with British Gas Corporation. After many years of research and animal experiments, last year ICI finally brought into service at Billingham the first "large pilot plant" designed to ferment methanol to produce proteins from unicellular organisms for sale under the trademark "Pruteen." With a capacity of 60,000 tons/year, this installation is indeed already an industrial

unit whose extrapolation to 300,000 tons/year should pose no further major problems.

At the Agriculture Show we met with Ian Beatty, ICI, commercial manager for Pruteen, and Michel Maisonnial, spokesman for the Agriculture Service of ICI France, and we tried to find out more from them about the principal technical and commercial aspects of this new class of products intended to find use in animal nutrition products, for which the French market obviously represents an outlet of primary importance.

Informations Chimie: Could you tell us of the path which led you to the start-up of your Billingham unit? What in particular are your short-term production objectives?

Ian Beatty: After having tested our protein, first in the laboratory and then on a small pilot, we decided to construct a large experimental unit before plunging ahead with industrial-scale production. The Billingham Pruteen plant was planned for that purpose, with a capacity of around 60,000 tons/year. As a matter of fact, its central component, the fermenter, was constructed in France, in Dunkerque, and then set up in England. The unit was completed 1 year ago, and, to begin with, its production was about 1,000 tons per month; by June 1980 we had doubled that, and by December the plant was producing 3,000 tons/month. For March and April 1981 we anticipate a production of 4,000 tons/month, and we want to attain a total 1981 production of some 50,000 tons. At the end of 1981 or beginning of 1982, the monthly production ought to amount to 5 or 6 thousand tons, so that the 1982 output should reach 60 to 70 thousand tons.

Here we are of course dealing with a biological industry based on highly evolved technology. Since placing our Billingham plant in service, we have learned much more than during the 6 years with our pilot plant.

I.C.: Have you encountered serious problems with product homogeneity and keeping the product up to specifications?

Beatty: The uniformity of the product is a problem that we have solved; the uniformity improves constantly as the level of production increases, or as operations become more normal in the sense that they correspond to the scale for which the plant was designed. An installation which only operates at 20 percent of its capacity or dimensioning will be out of equilibrium, and it is necessary to try to produce at the planned scale. Today we are manufacturing 120-130 tons/day, and each time we increase production our product improves. Just last summer half of the product was not up to specifications, but by December 90 percent was in conformance. However, all of the product being sold under the Pruteen trademark does conform to the specifications.

I.C.: What strain do you use? There has been discussion of a new strain your people developed using techniques of genetic manipulation; is that already being used?

Beatty: We have used the same strain of microbe (Methylophilus methylotrophus) for 12 years. But we do include genetic engineering in our research activities.

We are trying to improve the strain in two respects: by increasing the efficiency of transformation of methanol into Pruteen and by improving the amino acid balance in our product; in particular, we are trying to obtain lysine and methionine enrichment.

However, all this work is still at the laboratory stage, and we have still not used the modified strain in our Billingham fermenter. The question could be settled in about a year. It is essential to point out, though, that our present strain does a considerable job: the fermenter is inoculated with some 20 liters of microorganisms, and 2 days later some 40 tons of living cells are harvested; then the process continues in a continuous fashion--every 4 to 5 hours there are 40 more tons of Pruteen. Our culture medium only contains very simple chemicals: oxygen is obtained from the air, ammonia provides the nitrogen, methanol furnishes the carbon and energy, mineral salts are the source for other elements (K, Na, Mn, etc) which are required for growth.

I.C.: The present installation being, according to your own statements, a "large pilot," what is the status of your project for a 300,000-ton/year installation?

Beatty: The possibility of a future installation with a capacity of 300,000 tons/year would represent a logical culmination of experience gained from operation of the large experimental installation. Its construction and operation would also be, theoretically, less costly on a relative basis.

Nevertheless, we think that we will need at least this year and perhaps next year as well before taking or planning to take this new step. Don't forget that this is an entirely new technology and a new plant whose operation is constantly being improved. Also, the highly complex general economic situation presently does not seem very auspicious for any investment in the chemical industry. Thus while waiting to decide our future orientation, we will gradually increase production at our Billingham unit, which we could perhaps bring to 80 to 90 thousand tons/year.

We estimate that in this field we presently hold a lead of 4 to 5 years over all other companies in the world; nevertheless, it is not the best moment for investing in the next step.

I.C.: This technology naturally interests all present or future producers of methanol; we know, for example, that the Saudis are very interested. Have you thought of selling the process to third parties?

Beatty: Everyone is interested in such technology, not just Saudi Arabia. Many countries are showing interest, and we receive numerous contacts. But we think that it is premature, that our technology has still not been developed far enough to consider assigning licenses. As I have already said, we ourselves don't intend to construct another plant for another 2 years, at the soonest! Honestly, at the moment we have nothing to offer to third parties. I estimate that in 1-1/2 to 2 years we will be better able to judge what direction we could take with this technology. For the moment I cannot give you a more precise indication on the direction our future decisions may take.

You see, our present problem is that we have developed a new technology and we do not know whether the market is already truly "ripe" to receive it or whether the economic situation is ready for it.

As for developing countries, our evidence suggests the product would be valuable to them, but they do not have the means to purchase it. That would be a very large market, but, in my opinion, the best solution for them would be for Europe to give them the chance to buy up the soybean meal, or any other protein meal, displaced on the market by Pruteen. As a matter of fact, we are already finding transport of Pruteen at prices compatible with the European prices is a delicate problem to solve. It would be that much more difficult in the case of African countries, to use them as an example, and that could impose a heavy burden on the cost of our product.

I.C.: What products would be your target of contention: What are the natural proteins with which Pruteen should compete?

Beatty: Pruteen mainly replaces fish meals. It could obviously be substituted for an entire series of other products: soybean meal, bone meal, meat, powdered skim milk (in the feeding of pigs). But since we have a unit which is relatively small (in comparison to European protein consumption) and costly, furnishing a high-analysis product, of high quality, the natural outlet for the product is to be found in replacement of the finest fish meals, such as the finest herring meals, for example. In the feeding of poultry, already some 20 million chickens have been raised on Pruteen.

I.C.: What are your views on the French market, and what advantages can your products offer the animal nutrition industries?

Michel Maisonnial: Up to now the majority of our Pruteen has been sold in Great Britain, but we have been conducting market tests in France for 6 years, starting out with the product obtained at the pilot plant. We have done a very great number of tests with the INRA [French Institute for Agronomical Research] and with most of the research stations, and also have contacts with the principal manufacturers of compound feeds and nursing formulations. Our pilot, though it furnishes us only 1000 tons/month, has nevertheless permitted sustained contact with certain French clients for 3 years or more. To certain clients we sell only very small quantities, 1 to 2 tons per month, but that is misleading, since some of the clients involved are interested in very precise applications of our product and have been testing and evaluating it.

As our Billingham plant gradually got under way, we intensified our French market penetration. The quantities remain limited, but they are increasing, and our objective is to sell 9 to 10 thousand tons of it by 1981; thus it is a substantial proportion of our total production.

We have two grades of product: one granulated, in the form of a fine "semolina," and the other in the form of a very fine powder. The granulated grade is intended for species of swine, poultry, and fish and other small species (animals raised for their fur, etc). The powdered product is being considered for nursing

formulations, where it replaces a part of the powdered skim milk and certain dairy by-products for slaughter animals and animals raised for other purposes. In France the market is divided about equally between these two grades.

The animal nutrition industry is interested in Pruteen not only for its intrinsic qualities but also because in the longer term the supply of fish meal may become problematic. I understand that many regimes can do without fish meal, but in France it is consumed at a rate of about 70,000 tons per year, and we have come to depend on it. Of course it is not a very profitable industry; France imports its fish meal mainly from Denmark and Norway, and it could be that in the long run there will simply not be enough available fish. The animal nutrition industries are thus in effect seeking a product of the Pruteen type that would be at least as good or even superior to the best sorts of fish meal.

A product such as ours could, in the long run, be the only solution. That is really one of the main reasons for the lively interest the concerned industries are showing in our Pruteen. Most of the large specialized companies have tested it or have contacted us. I think that we will be able to sell 60 to 70 thousand tons of it per year, depending on circumstances.

Clearly there are always going to be some economic problems, transport problems, etc. But fish meal also must be shipped from Denmark or Norway to France. To sum up, we have firm hopes of being able to carve out a respectable place on the French market.

I.C.: How do your prices stand in comparison to those of the products which you seek to replace?

Maisonnial: If our clients buy our product, it is because our prices are competitive on the French market. Having 5,000 tons of Pruteen to sell, we always manage to sell Prutene as a substitute for the better grades of fish meal, the better grades of herring meal for example. This is because compared to fish meals our product gives a considerable improvement in performance. For example, when fish meal in the feed formulations for poultry is replaced weight for weight with Pruteen, one finds a 1 percent improvement in weight gain, for pigs this improvement is about 4 to 5 percent, and in the case of fish it is about 10 percent. For all species, therefore, one finds a clear increase in performance. It is thus evident that, even at higher prices than herring meal, Pruteen brings something more to the manufacturers of animal nutrition mixes.

Moreover, we now have an industrial product, a product which is regular and constant from the standpoint of its analysis. The uniform quality is clearly one of the great advantages of Pruteen. Our product is also totally free of every kind of chemical pollution and all physical or biological contamination. It does not undergo any storage or passage in silo. Pruteen is delivered in 20-ton containers, each container containing a plastic bag in which we condition our product. Pruteen is thus a pure product, a product of high quality.

I.C.: Turning now to your raw material, methanol, what is your position in this field and the outlook for supply on the world market?

Beatty: ICI is the largest producer of methanol in the world. Eighty percent of the methanol plants installed during the last 10 years utilize the ICI low-pressure technology and most of the methanol plants use the ICI catalysts. It is thus a field that we know particularly well. But, even though methanol shortages should not arise in the next few years, it is nevertheless necessary to predict that it will remain a relatively costly product. The reason? At the present time a substantial number of methanol units are planned or under construction, but 3 or 4 years ago the installed capacity was inadequate. To the extent that this gap is not corrected, methanol will remain expensive. I think, however, that countries such as Saudi Arabia or Mexico will be producing it; in the Soviet Union, in North America, in South Africa, where coal is abundant and cheap, methanol will be produced from coal. It is estimated that in the coming 10 to 15 years the price of methanol will gradually decline, at least in relation to energy prices and after adjusting for inflation. Little by little, large capacities will be installed, methanol will be produced on a very large scale, and it will partially substitute for gasoline. I understand that France has just signed an agreement with the Norwegians to begin producing some methanol for fuel. But, for application in this field, it is necessary to be able to produce it at a sufficiently low price for it to be competitive. If things turn out that way, we would be in a very good position in comparison to fish meal! It is reasonable to expect that such a price relationship will develop in 10 or 15 years, but probably not during the next 5 years.

I.C.: You took up the torch after BP, which had been first in proteins from unicellular organisms. Has that experience been profitable to you?

Beatty: The BP unit, which had to be shut down, has aided us in making inroads on the French market. Thanks to that program, the French already knew about "SCP" [single-cell protein]. After doing pioneering work in this field, BP apparently encountered all the difficulties which a pathfinder must overcome, and perhaps BP arrived on the scene too early. Nevertheless, the BP product permitted the testing of unicellular proteins. Evidently their product, based on petroleum, was too costly. But it was a quality product, as was the product furnished by the Italian BP installation.

Average composition of granulated Pruteen	Percentage based on raw product
Moisture	8
Crude protein	72
Ash	10
Fat	8.5
Cellulose	<1.0

Amino acids	Percentage based on raw product
Lysine	4.1
Methionine	1.4
Cystine	0.5
Threonine	3.3
Tryptophan	1.0

Minerals	Percent
Phosphorus	2.1
Calcium	1.3
Sodium	0.8
Potassium	0.18
Magnesium	0.22
Chlorine	0.03
	Ppm
Iron	350
Copper	< 30
Zinc	< 50

9828
CSO: 3102/301

BRIEFS

HUMAN ENZYME CLONED--Montecatini Terme, Italy--For the first time in the world a human enzyme has been cloned at the International Institute of Genetics and Biophysics of the National Research Council (CNR) in Naples. This discovery was revealed 7 May by the president of CNR, Prof Ernesto Quagliariello, during a scientific congress being held in Montecatini Terme (Tuscany). This is only the second time ever that a human gene has been cloned, the first being the cloning of globin in the United States in 1977. The cloning was achieved by a group of researchers which worked under the supervision of Prof Lucio Luzzato, director of the Neopolitan Institute, until last January when he returned to London to direct the Department of Hematology at Hammersmith Hospital. The discovery crowns research work which lasted 10 years. The cloning was carried out on a fragment of DNA for the enzyme glucose-6-phosphate dehydrogenase, mutations in which can be responsible for a serious blood disease known as "favism," which is prevalent in Sardinia (several hundred cases) and in Sicily. Favism is an intoxication due to the ingestion of certain broad beans (Vicia fava). In affected individuals the ingestion leads to severe hemolytic anemia due to the absence of an enzyme, glucose-6-phosphate dehydrogenase. The cloned enzyme gene is part of the DNA chain of the X chromosome, a sex chromosome; a female possesses a pair of such chromosomes, one active and the other not. Thus it would be possible to study more precisely the mechanism of this absence of activity which has important consequences. [Text] [Paris AFP SCIENCES in French 7 May 81 p 26] 9828

CSO: 3102/301

COMPLETELY NEW METHOD OF OFFSHORE EXPLOITATION PROPOSED

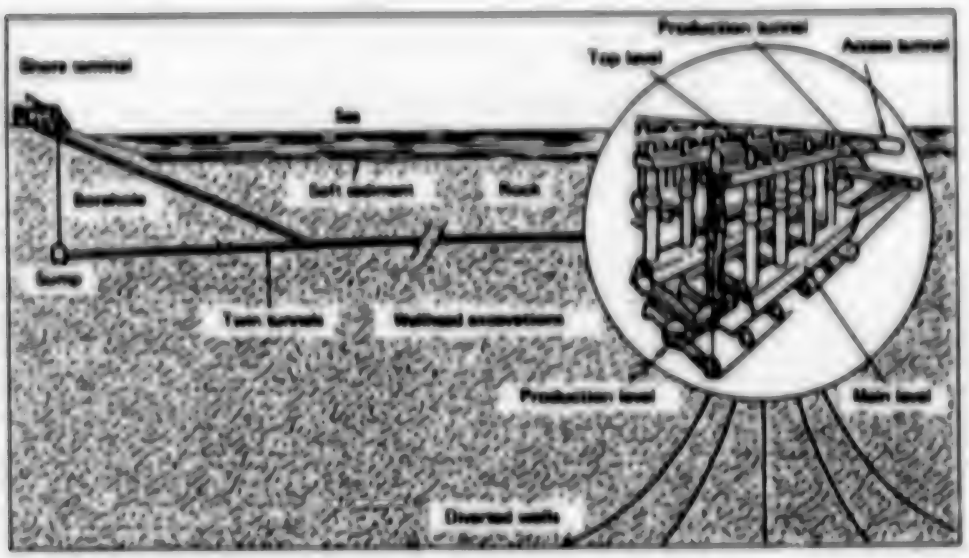
Duesseldorf MT MEERESTECHNIK in German Apr 81 pp 53-54

[Article by Piers G. Harding: "Team of Scientists Recommends Offshore Oil Production By Tunnel"]

[Text] Scientists at the University of Newcastle upon Tyne, internationally famous for research in the areas of geomechanics and tunnel building technology, have developed a totally new plan for future oil production from offshore deposits, which proposes the construction of tunnels and subterranean "drilling towers."

The study of the Newcastle scientific team, working under the direction of Prof E.L.J. Potts, was subsidized by the Offshore Technology Board of the British Ministry for Energy.

The construction of a parallel double tunnel from the coast is proposed for oil production under conditions such as obtain in the North Sea or in even more inhospitable regions. The tunnels would have a gradient of up to 10 percent for several kilometers and in the final section an additional incline of 0.15 to 0.2 percent. At regular intervals links are provided between the tunnels, as well as water and gas bulkheads. From the end of the tunnel vertical wells would be sunk above each oil deposit in the bedrock lying approximately 100 meters under the seabed (Ill. 1).

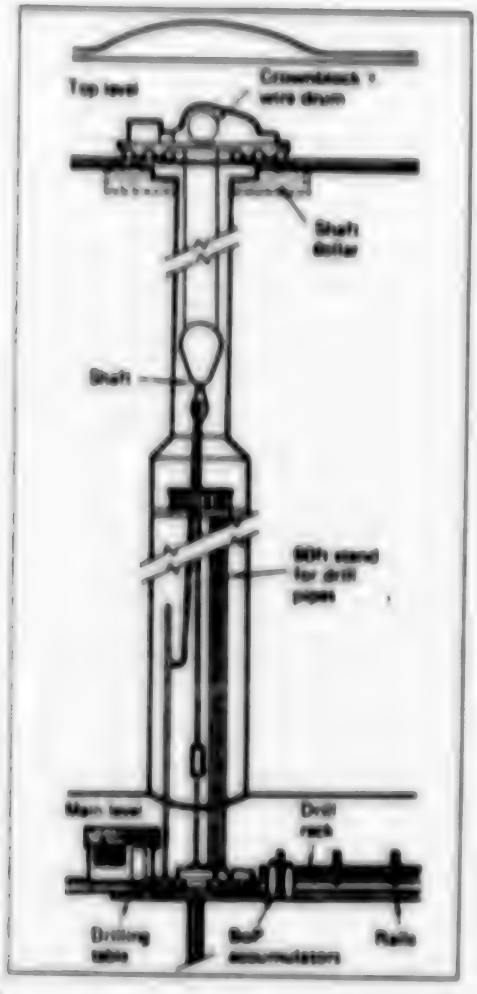


Ill. 1: Plan for tunneling under the seabed for oil production and (inset in the circle) the wellhead production area with the vertical shafts for the drilling equipment.

The study designates one of the tunnels for access; it will be equipped with a twin-track rail system, on which all the material and the labor force could be transported to the site. A traveling time of 1 hour is calculated for oil fields situated 50 kms off shore, i.e., a speed of about 50 km/hour. Electrical power supply will also be routed through the access tunnel. Present day offshore production plants generally generate their own current. But if the power supply can be laid through a tunnel, the generating source can be shifted to dry land, which is considerably less expensive.

The second tunnel will serve to transport the oil or natural gas that is produced and also for ventilation. Even gas that is currently flared off because the construction of an underwater pipeline would be uneconomical could be piped to the coast in this manner. According to the plan, this production tunnel will act as a secondary emergency exit, for which a monorail system installed under the tunnel roof would serve as transportation.

The drill hole production area can best be described as a complex of horizontal tunnels at several levels, which are linked by vertical shafts. Twenty drill shafts are planned, which will be sunk using hydraulic rock borers. Shaft walls, which could easily accept the resulting pressure, would replace the drilling towers at traditional wells. The shafts will be linked with one another at the upper and lower ends by horizontal tunnels (Ill. 2).



Ill. 2: Detail drawing of a drill shaft.

The crown block and drilling machinery will be installed on the upper level, while the lower level is planned as the drilling level with the drilling table. Drilling operations would be controlled and supervised from this position.

The crown block, drill cable, drill feed and piping are suspended in the vertical shaft. The drill feed leads through the drilling table, and as is customary, the drilling operations are controlled from the main level. The plan provides sufficient space for extending the drill pipe from a single length to three, four or more lengths. The number of shots for perforation can be altered to suit the increasing distance between the two levels.

Under certain conditions this could offer the following advantages: Speeding up the replacement of a drill bit. During the replacement the lengths of pipe could remain in the drill shaft or be stored to the side of, or below, the main level. The plan is based in principle on the use of standard drilling equipment.

The stockpiling of large quantities of piping and other bore hole supplies on the production level could be dispensed with, since the material could be moved from a coastal terminal as required, thanks to the rapid transportation link. Proper drilling operations could be begun as soon as three or four of the vertical bore hole shafts had been sunk. After drilling operations in one shaft had been terminated, the equipment could be moved to the next one through the vertical levels.

According to the study, the possibility of storing equipment exposed to the risk of fire or explosion in separate, explosion-proof chambers would exist. A ventilation system for the entire project would ensure concentrations of air in the event of minor gas leaks.

The team of scientists in Newcastle is convinced that oil exploitation through the use of tunnels is absolutely practical and in this connection they point to similar technological achievements that have already been realized in British coal seams extending under the seabed and in various other projects around the world.

The complete isolation of oil and gas production from the surface and the total protection of operations and structures from the sea and the seabed would mean that they could be carried out in great depths of water and under the worst weather conditions imaginable.

Risks, such as those posed by icebergs and heavily traveled shipping lanes, could be ignored; the dangers of pollution--such as the poisoning of important fishing grounds or the fouling of beaches by oil sludge--would be eliminated.

According to reports, both capital and operating costs for the project will be lower than for production from drilling platforms, particularly in inhospitable regions such as the polar zones. Lower expenditures would go hand in hand with a maximum oil and gas potential.

In the case of a North Sea oil field of medium size, the scientists project that the tunnel method of exploitation would be about 30 percent cheaper than with platforms. Furthermore, they see no practical reasons that would make its realization impossible. In their opinion geological conditions in the area of the British Moray Firth are particularly favorable.

Once subterranean exploitation has begun, continuous operation would be extremely economical, and up to 50 percent could be saved compared with normal platform operating costs. The expensive use of helicopters and supply ships would be rendered superfluous, as would the problems of generating energy and heating, of protection against frost, drainage and freshwager storage at sea.

In addition, another important cost factor in platform oil exploitation--housing technicians and other staff--would be completely eliminated. All those involved could travel to their place of employment each day from lodgings on the coast. During the trip films about technical training and safety could be shown in order to familiarize the staff with the total concept of subterranean exploitation.

For the construction of the first tunnels and vertical bore holes calculations predict a capital expenditure similar to that for the construction and installation of production platforms. In the case of very long tunnels the initial costs would be higher and the breakeven point would be reached later--but in the opinion of the Newcastle scientific team the end effect would be to increase overall profits greatly.

9581
CSO: 3102/286

CHEMICALS

NEW TYPE OF DRILLING PLATFORM INTRODUCED

Duesseldorf MT MEERESTECHNIK in German Apr 81 p II

[Article: "Noncapsizing Semisubmersible Platform Developed in Norway"]

[Text] A new type of drilling platform was introduced by the ship consulting firm Shipping Research Services (SRS) in Norway. According to one of the company's press announcements this platform meets even the most rigid requirements with respect to safety. In addition, the operating costs are well below the usual. SRS is already negotiating with potential partners for this platform project.

Six columns connect the deck structure with the hull-shaped pontoons. The deck structure is a closed watertight section to guarantee additional flotation and to prevent capsizing, in the event that the platform should suffer severe damage (Ill.).

Double diagonal braces between the column and the deck structure ensure adequate constructional rigidity. Horizontal struts were avoided to keep down the number of difficult welding points in the steel construction. The braces can be inspected at all times from the inside. The designers followed the tighter regulations of shipping authorities concerning stability, rescue equipment and anchoring.

Die Plattform bietet mehr Platz für Lagerung von Rohren, Brennstoff, Bohrwasser, Zement usw. als frühere Plattformtypen. Dadurch ist sie von Versorgungsschiffen weniger abhängig als bisher.
Bild SRN

111. The platform offers much more space for the storage of pipes, fuel, drilling fluid, cement, etc, than earlier types of platform. Consequently it is less dependent on supply ships than before.

9581
CSO: 3102/286

BRIEFS

FUNDS FOR UNDERGROUND GASIFICATION--Paris--The signing 5 May of a financial agreement between Minister of Industry Andre Giraud and the Group for Underground Gasification Studies (GEGS) for 1981 will enable underground coal gasification experiments to go forward in France. The signing of this agreement has been expected since 27 January of this year when spokesmen from the GEGS (which includes the French Gas Company, French Coal Board, French Petroleum Institute, and Bureau of Geological and Mining Exploration) announced a program involving Fr 125 million for the 1981-1984 period. Forty percent of the funding is being contributed by the European Community, 30 percent by the French government, and 30 percent by the GEGS partners. This Fr 125 million research effort, emphasized the minister of industry, represents "a quadrupling as compared to the previous program." An initial coal gasification experiment has already been carried out at Bruay-en-Artois. (See AFP SCIENCES No 247, pp 52-56.) [Text] [Paris AFP SCIENCES in French 7 May 81 pp 20] 9828

CSO: 3102/300

PRINCIPAL THEMES OF FRENCH ROBOTICS RESEARCH REVIEWED

Paris LE NOUVEL AUTOMATISME in French May 81 pp 62-68

[Article by Philippe Coiffet* and Claude Laurgeau**: "French Robotics Research: From The Intelligent Robot to the Flexible Workshop".]

[Text] For a little over a year, public research in France has taken shape. Although with smaller means than Japan or the United States, the French government has attempted to give robotics research a direction and to coordinate the efforts of many laboratories in this area. A national project labelled ARA (Advanced Automation and Robotics[1] [please see end of article for list of abbreviations used] has been set-up to gather most of the robotics effort and give a direction to advanced research in this area. The ARA project includes 29 university laboratories, either public or belonging to the CNRS (National Center for Scientific Research). Although this project is important, and welcome, it does not claim to cover the whole of the French effort in the area of robotics.

Without pretending to be all-encompassing, we will attempt in this article to classify the main themes in French robotics research.

Some Dates and Statistics

The first industrial robot was built in the United States in 1962. The first Japanese robot appeared in 1967. In France, Renault began design and production activities in 1974. Today, there are 130 robot manufacturers in Japan, about 40 in the United States, and less than 10 in France. For the year 1978, the following figures concerning Japanese research have been collected: 170 researchers in 50

*Head of Research at the CRNS, Montpellier Automation Laboratory, Place Eugene Bataillon, 34060 Montpellier Cedex.

**Professor at the Nantes University, Automation Laboratory, ERA 134 ENSM, 1 rue de la Noe, 44072 Nantes Cedex.

1. Georges Giralt - Research Director at the CNRS--initiated the ARA project. He manages the coordination office, the highest level of technical responsibility.

university laboratories, 71 researchers in 23 public laboratories and an unknown number in private laboratories[2]. As far as we know, no comparable statistics have been gathered in France. If we take the risk of an approximate evaluation, we believe there are about 60 university or public sector teams representing about 150 researchers concerned with themes associated with robotics.

The first requests for quotations from the DGRST (General Delegation for Scientific and Technical Research) specifically directed to robotics went out in 1976. Since then, other actions of the same type have stimulated and given a direction to French research. During this same period, the CNRS has established several ATP's (Theme-Oriented Programmed Actions) concerning robotics - or artificial intelligence. These actions by ATP's or the DGRST are undoubtedly stimulating research on specific themes chosen by the scientific management of these organizations. Consequently, research is oriented through the financing of selected projects. But besides the orientation of research, the coordination of multiple laboratories on the same subject is another problem. An experiment of this type has been conducted within the scope of the SPARTACUS project, which has been for several years the focus for medical robotics research. The 4-year national ARA project, begun in 1980, will also attempt this double objective of orientation and coordination while covering most of the research necessary for rotobics.

The Three Robots

We will not go back to known definitions concerning industrial automatons, handlers, and robots, or the successive robotics generations (pick-and-place and playback robots)[3]. However, the problems presented by robots as such are very different according to whether one is interested in production robots, exploration robots, or assistance robots.

--Production robots, also known as industrial automatons, are used for repetitive tasks in quasi-invariable environments. Prototypes of this family of robots are welders, painters, and handlers. These types of robots only differ from numerical control machine-tools by their mechanical architecture and the variety of programmable tasks.

--Exploration robots, or simply robots, have almost nothing in common with production robots, except for their mechanical morphology and the most elementary levels of control. The main problem with these robots is that the machine knows its objectives, or the task to be accomplished, but its environment is no longer invariable. There are two types of solutions to solve this problem.

The first is to provide the machine with sophisticated sensors (visual, sound, touch..) and processing and interpretation algorithms defining its environment. This approach tends to make the machine autonomous and results in the exaggerated definition of the robot as an "intelligent robot."

---

2. Article by Michel Maison: Japanese Industry - The Necessary Triumph of Robotics. Le Nouvel Automatisme, No 19, pp 34-43.

3. Claude Laurgeau, Le Nouvel Automatisme, No 18, pp 37-46.

The second approach consists in leaving the human element in the control loop, and defines the important area of "remote operation."

--The assistance robot may be a simple gadget (home appliance) or, at the other end of the spectrum, a critical support for the handicapped (prothesis, orthesis, or telethesis). The assistance robot then seems like an integral part of man or an extension of the human being, and man/machine interface problems are therefore critical.

Classification of Research Themes in Robotics

Without underestimating the development and improvement effort necessary in the area of production robots, it is obvious that most of the effort in robotics research is in the area of exploration robots. It is difficult to classify the numerous research subjects, but we may offer the following 4-point approach:

--The first subject concerns the very existence of robots, that is, their mechanical characteristics and technology. Within this general area, we find the improvements to existing production robots, and more generally, a general assessment of robot design and manufacturing problems.

--The second subject concerns the efforts to make exploration robots autonomous and defines "intelligent robotics."

--The third focus is in the study of man/robot relations, or in other words in the area of remote operation.

--Finally, whereas exploration robots do not exist today, production robots may be considered as the state-of-the-art in the technology. It is therefore necessary to study the relationship between robots and production machines and get the first benefits from production robotics: This is the area of flexible workshops.

Research on the Mechanics and the Technology of Robots

In most cases, currently used robots have not been the object of basic research at the architectural concept level. Manufacturers have used the conventional machine-too- know-how, have developed some specific elements (wrist joint with three intersecting axes, elephant trunk, etc..) and, pressed by time, they have put them together, hoping to obtain a fast and accurate system capable of carrying the heaviest possible load. If designing a universal robot is vain hope, one can at least conceptualize multifunctional machines by drawing upon two main ideas: modularity and scale factor.

Research on mechanics and technology in robotics includes the study of modules, articulated joints, transmissions, motorization, sensors, and overall integrated architecture. Innovative research along these lines requires mechanical technology specialists with extensive knowledge of the mechanisms involved. Specialists of this type are fairly rare in France where theoretical mechanics is emphasized. We suggest the following main subjects for thought in the area of robots mechanics and technology:

Basic Themes

--Description and classification of the tasks applicable to robots.

--Relation between the task parameters and robots' morphology.

--Influence of the scale factor on robot architecture.

--Models representing robots' mechanics.

--Theoretical and technological study of gripping.

--Relationship between mechanical systems and their control by computer.

Development of New Robotics Components

--Actuators: miniaturized hydraulic components, stepping micro-jacks, etc.

--Sensors: tactile, proximity sensors, tri-dimensionnal vision, etc.

--Special modules: master mini-arm, tool carriers, etc.

--Operational reliability.

--Use of new materials: carbon fibers, etc.

Problems Related to Industrialization

--Modularity and scale factor.

--Integrated architecture, industrial design.

The main French laboratories working on these themes are the following:

--Surface technology laboratory of the Ecole Centrale de Lyon (study of friction in articulated joints).

--Mechanics laboratory of the Ecole Centrale de Paris (motion transmission).

--Besancon Applied Mechanics Laboratory (structure of mechanisms with complex trajectories programmed from a single actuator).

--Mechanics laboratory of the Poitiers University (mechanics of gripping).

--Industrial automation laboratory of the Lyon INSA (development of models of electro-hydraulic actuators).

--Technical studies office for the protection of the Saclay CEA (cable and ribbon transmissions and master mini-arms).

--Besancon Automation Laboratory (ENSMM) (study of miniaturized hydraulic actuators--development of multidimensional motion sensors--modular microrobotics structures).

Private robot manufacturers (Renault, Languepin, AOIP, CEM, ACB, etc..) are faced with the necessity of resolving every machine structure problem as it occurs. Current economic pressures seem to leave little time for them to study basic problems and to pursue exhaustive basic research.

Research on Robot Autonomy

As opposed to conventional numerical control machinery or industrial automatons operating within a deterministic environment, robots are intended to perform tasks without having exhaustive prior knowledge. This capability of the machine to react in an environment which is not known to begin with requires a relative autonomy of the robot. We will attempt to classify the numerous problems which remain to be solved in order to reach this objective at least partially.

Control

Robots used for a given task must be controlled in a flexible manner along complex trajectories. This assumes full mastery of positions, velocities, and forces, and coordination of machines working together on the same task. Head trajectory is determined by the robot itself from information about the task to be performed and its environment. From the desired trajectory, it is necessary to determine the time sequence of the signals controlling the various joints. In today's robots, positioning or velocity control are operational but do not take into consideration the dynamic phenomena which may disturb the motion at high speed. The dynamic model of the robot is not invariant, but depends upon the load, the velocity, and the various head configurations. A complex control sequence cannot be determined once and for all but requires on-line mixed control sequence identification operations performed in real time. Adaptive control involves the various types of research performed in order to relate the control algorithm to the model variations, using information sensed from the head and processed on-line. Such studies are being conducted at the Toulouse CERT [Studies and Research Center], at the Rennes IRISA, and at the Montpellier LAM. A complete understanding of forces and relations between mechanical contactors is necessary in order to comprehend the important assembly objective in robotics. The implementation of active compliance sensors on terminal components and the interpretation algorithm in handling problems are being studies at the Toulouse LAAS [Laboratory for Automatic Control and its Space Applications].

Perception

Robot autonomy requires the capability of informing itself about its changing environment. The subject of perception therefore includes sensors and the processing necessary for usable interpretation of the raw data. A robot must be able to localize, recognize, verify conformity of objects in its environment in order to pick them up, move them without collisions, assemble them.

Research conducted on the theme of vision is concerned both with new types of sensors, particularly stereo vision sensors, and with methodologies for image modelization,

shape recognition, and scene analysis. Bi-dimensional vision (video cameras, photodiode matrices) may be sufficient in certain classes of problems: quality control, positioning, recognition of flat objects or objects with a finite number of equilibrium positions. But tri-dimensional vision remains necessary to resolve a number of important problems such as intelligent grasping of not previously known objects, recognition of bulk objects on a plane with partial overlap, real bulk, scene analysis. The first stereo vision sensors are beginning to operate using two cameras observing the scene. The 3-D image is constructed by sequential high-speed scanning of points in the observed scene, using a laser spot. One such system is operating at the INRIA. A plane stereo-vision variation using the translation motion of objects to construct the third dimension is being used at the Nantes LAN. An intermediate solution if K2D vision, which utilizes several two-dimensional images taken from several viewpoints (LAM). Other research is being conducted on vision-sensing equipment, in particular the study of a color sensor (GTTSI in Toulouse), the integration in cable technology of some signal pre-processing or simple recognition operators (LETI in Grenoble).

The processing of images for shape recognition runs into four main difficulties: The considerable volume of raw data, the variance of images in rotation, object translation, problems of lighting and perspective, time constraints.

Difficulties vary greatly depending upon the basic hypotheses: motionless isolated object, objects in a translation motion, bulk objects on a plane without overlap but in a translation motion, bulk objects on a plane with overlap, three-dimensional bulk. Research is oriented toward the development of models, particularly models of geometric shapes, the recursive nature of processing algorithms, model structure, interpretation, classification, and decision methods. Numerous research teams, not especially robotics oriented, are working on image analysis and shape recognition. Among robotics-oriented teams working on vision problems, we can name the Toulouse CERFIA, the Grenoble LAG, the Nantes LAN, the Paris LAAS and DSC for background analysis, and private laboratories (Thomson, Renault, Phillips, etc.).

Another artificial sense which is useful to the robot is the sense of touch. Robots can use touch to recognize a local environment (for instance following an edge in the case of a welding robot) or control micro-displacements in assembly operations with tight tolerances (vision is not sufficient in this case). The LAAS, the LAM, the Spartacus laboratory, the CEA STEP have been working for a long time on these problems. The first industrial robot to make use of these techniques is the results of the LAM work (Jallatte robot for carding).

Between vision at a distance and touch, we find the whole class of proximity sensors, which use elements from both techniques, and which is the specialty of the Rennes IRISA.

It is tempting to place the recognition and restitution of vocal or simply sound information in the category of perception. In fact, the vocal aspect falls more within the realm of man/machine communication at the level of task probramming, rather than the operation of an autonomous robot. For quite some time, sound recognition as been the object of studies at the Orsay LIMSI, at the Toulouse CERFIA, at the Nancy CRIN, and at the Lannion CNET. These last two laboratories are also working on language recognition.

The Process of Communication and Decision

Man/machine communication takes place mostly at the level of the definition of the tasks to be performed by a robot, although it is possible to visualize human intervention during task execution. Communication must be characterized by a high semantic level and a flexible syntax. Gesture support is an efficient programming mode used today in industrial automatons ("playback" robots for welding and painting, etc.). Because of the difficulty in describing complex trajectories with instructions, the success of this type of dialogue using dummies, syntaxers, joysticks, etc.. is understandable. Graphic approaches (light-pens, writing tablets, visual displays) could constitute an intermediate solution toward conventional information languages oriented toward the control of robots. Some robot control languages already exist (VAL, Emily, AL, Autopass, Lama, etc..) but they are not yet used on an industrial scale. The problem bears no relation with that of numeric control languages for machine-tools (APT, PAM, Promo), because the final primitives of the language, acting at the home location of the actuator, are created by the plan-of-action generator from task instructions and from context analysis. A main characteristic of a language is the ability to apply it from one robot to another. The higher the level of the language, the easier it is to transfer, but the more difficult it is to apply the primitives it calls upon. The Grenoble IMAG, the Evry Spartacus laboratory, and the Orsay GIXI are all working on these problems.

The set of methods which allow a robot to carry out tasks from established instructions and from the analysis of the environment constitute the plan-of-action generator. The generation and optimization of these decision-making procedures are incorrectly called "artificial intelligence." The laboratories working in these areas are the LAAS, the Toulouse LSI, the Compiegne DIC, and the Paris LITP.

Robot Integration

Although intensive research in specific areas is necessary, so is an effort to synthesize the results in order to develop the "total" robot. Computer and graphic techniques can be used to perform simulations of articulated systems and to apply heuristic methods for the development of robot systems. A tool of this type for computer-assisted robot design is being developed at the Montpellier LAM. Research on mobile robots is also placed in this category. Although it is possible to ask questions about the potential use of robots of this type, they constitute excellent supports for research. These machines must be able to move in partially known environments and allow an understanding of the many important difficulties to be found in advanced robotics. Several projects are being developed in France: the Latea robot at the Rennes INSA, the Marseilles EIE robot which identifies electrical outlets in order to recharge itself, the asparagus harvester robot of the Bordeaux ENSERB, the Valenciennes LIR$_2$P robot, and the LAAS Hilare robot, which is the most sophisticated and ambitious project. Synthesis research in data-processing (LIMSI), or the integration of complete robot systems (LAAS) are the end-result of the overall research effort of well-structured teams.

Research on Relations Between Man and Robots

An intelligent robot is a machine with a high degree of autonomy in which the man/machine relationship takes place at a high semantic level through vocal or visual but non-gestural communication. This type of robot does not exist today although

many complex tasks must be carried out in non deterministic and hostile environments. Remote operation, which is characterized by the required and permanent presence of man in the control loop, constitute one solution to this type of problem.

The first remote-handlers appeared at the same time as nuclear metallurgy, toward the end of World War II. In France, there is only one developer of remote handlers (the CEA) and only one manufacturer (Calhene Co).

An important desired characteristic of remote operation is the transparence of the system its unobtrusiveness, so that the human operator has the feeling of carrying out the task with his own hands, or with tools. The interactive master-slave relationship may include power amplification in the master-slave direction, and information feedback in the slave-master direction.

French remote operation technology is in a good position internationally. However, some new classes of applications such as the space environment with platform assembly on orbit and satellite maintenance, underwater environment for nodule and oil exploration, the nuclear area including maintenance and tearing down of installation, all require new progress in advanced remote operation. Among the main themes of research are:

--Remote operation with reduced vision, limited flow of information, or transmission delays.

--Development of partial autonomy for the slave system in order to accomplish certain tasks to lighten the burden of the human operator.

--Homomorphy of motion in order to simplify the relation between the slave motion and the control gestures in the master structure.

--Two-handed operation, or even more, creates problems of motion coordination and of definition of the master structure.

--The increase of sensorial feedback to the human operator, particularly tridimensional vision of the slave environment.

In French laboratories, problems of human factors and organization of work stations are being studied at the Orsay LPM and at the Spartacus laboratory, feedback of pertinent information by the Spartacus laboratory, the addition of automatic mechanisms to improve operator efficiency at the IRISA and at the LAM. These automatic mechanisms are not necessarily operational at all times and it is necessary to develop the optimum strategy for their start and stop (Lille CAL). These systems are very complex, and even the evaluation of their performance meets with problems (U103 at the Montpellier INSERM). Their maintenance and troubleshooting also deserve some study (Marseilles LAIM).

It would seem that the only research group organized to work on remote operation is related to the national ARA project. This is due to the fact that remote operation studies do not result in mass production and that applications are specific and characterized by the complexity of the handling tasks. Besides the important requirements of the nuclear industry, projects are mostly concerned with single pro-

ducts: French Petroleum Institute project on deep underwater pipeline assembly using remote operation, National Center for Space Studies project for the maintenance of orbiting satellites, or project of the office for underwater exploration (Eric device equiped with a remote-handling arm).

Medical assitance robots constitute a specific field of investigation because the human operator does not have full availability of his capabilities and because of the great variety of sensorial or motor handicaps. Protheses, ortheses, and teletheses alone fall within the scope of robotics. The Spartacus laboratory had assembled a large number of laboratories to work on medical robotics. A few teams are still working on these problems such as the U103 at the Montpellier INSERM with the Onami project to develop a walking orthesis, and the Nantes LAB and ENSM (artificial hand).

In conclusion, we may say that, as opposed to general robotics which involves mass production and will lead to manufacturing of robots in quantities, remote-handling involves advanced technology areas and leads to implementation of single systems, or small productions. The effort for the development of remote-handling is nevertheless critical economically for the exploitation of natural resources and of technical processes in hostile environments.

Research on Robot Production Machine Relations

This chapter covers the study of automatic integrated design and control methods and tools for flexible production systems. In the last decade, production automation has lead to the creation of automated machines at the local production level, presenting a certain amount of multi-functionality (for instance numeric controlled machine-tool centers), machines integrating fixed transfers (transfer machines), or even some transfer flexibility (fee robot). However, today's automated workshops are limited to manufacturing a limited number of products because of the fixed structure of the workshop. The life-span of a production unit is related to that of the products and highly automatic units are reserved for mass-production. On the other hand, flexible workshops are mainly applicable to small or medium production of diversified objects produced concurrently on the same assembly line.

A production unit includes:

--work-stations

--parts flow

--tools flow

--management information flow

--control information flow.

Program flexibility is based upon the following four main components:

--programmed automation of the different machines

--flexibility of the transfer modules

--warehousing of parts and tools

--computer-controlled coordination system.

By analogy, we can say that the flexible workshop is to the conventional workshop as programmed logic is to hard-wired logic.

Since autonomous robots have not yet reached their maturity, or been subjected to the trial of industrial experience, it would seem premature to have robots cooperate with conventional production machines. In fact, the industrial automaton operating in a deterministic environment may be considered as the state-of-the-art in the technology. Research on flexible automation is mainly directed to the integration of these "playback" robots into production cells. Renault is thus setting-up a machining flexible workshop at Boutheon, near Grenoble. Among research themes on flexible production we may list the following:

--Formalization and modelization of flexible workshops.

--Development of computer simulation programs and workshop design programs.

--Architecture, storage, transportation, inspection.

--Real time control: logistics, production management.

--Data processing systems: data acquisition and processing.

Because of the strong industrial implication of these subjects, it is necessary to consider them from a broad viewpoint and with a good knowledge of production problems in order to fully understand them. For obvious economic reasons, university researchers can only experiment using simulation or remain within the bounds of very specific projects. Renault holds a leader's place in this area since it is capable of creating and experimenting in actual workshops. Besides Renault and Telemecanique Co in the private sector, about ten French teams are working on these subjects. Specialists can be found mainly in Toulouse (LAAS and CERT), Bordeaux (GRAILD) Grenoble (IMAG), Nancy (CRIN), Valenciennes (LAIH), and Pris (LAMSADE).

Conclusion

This compilation of the main areas of research conducted in France in robotics is probably incomplete. A large number of fairly well defined themes have however been explored. Without speaking about a French School of Robotics, it is possible to state that a certain know-how dies exist. Although France is certainly behind in industrial robotics, particularly in the areas of production and robot application, it nevertheless holds an honorable position. In the last few years, a large number of research teams have directed their effort toward the dynamic subject of robotics. Except for a few established and structured laboratories, many teams are made up of a few very motivated but isolated young researchers who have difficulty in finding original research subjects. Although the Administration has made a financial effort in the area of equipment, the effort has been nil in the area of job creation. This policy can only have serious consequences since a critical mass and some competition are necessary in order to fully understand some research problems.

The implementation of the national ARA project, which uses a large number of teams on a large-scale endeavor is an interesting attempt to pull together and to coordinate public research in robotics. The time and manpower and financial resources necessary to find solutions to the many problems we have just reviewed should not be underestimated.

MAIN ABBREVIATIONS USED

LAIH : Industrial and Human Automation Laboratory--Valenciennes University

CRIN : Nancy Data-Processing Research Center

CERFIA : Cybernetic in Enterprises--Shape Recognition--Artificial Intelligense--Toulouse

IRISA : Data-Processing and Random Systems Research Institute--Rennes

LAAS : Automation and Systems Analysis Laboratory--Toulouse

LIMSI : Mechanical and Engineering Sciences Data-Processing Laboratory--Orsay

LIMAG : Data-Processing and Applied Mathematics Laboratory--Grenoble

LAN : Nantes Automation Laboratory--ENSM

LAM : Montpellier Automation Laboratory

LAG : Grenoble Automation Laboratory

GTISI : Television and Image Signal Processing Group--Toulouse ENSEHT

DIC : Compiegne Data-Processing Department

LITP : Theoretical Data-Processing and Programming Laboratory--Paris

DERA : Automation Studies and Research Department--Toulouse CERT

LETI : Electronics and Data-Processing Technology Laboratory--Grenoble CENG

INRIA : National Institute of Data-Processing and Automation Research--Rocquencourt

DSC : Communications and Systems Department--ENS Telecommunications--Paris

LAIRA : Automation Laboratory--Rennes INSA

EIE : Electronics Engineering School--Marseilles

ENSERB : National Superior School of Electronics and RadioElectricity at Bordeaux

LIR$_2$F : Robotics Data-Processing and Shape Recognition Laboratory--Valenciennes

6445
CSO: 3102/299

NEW METHODS OF SURFACE TREATMENT EXHIBITED AT SHOW

Paris L'USINE NOUVELLE in French 28 May 81 pp 81-83

[Article: "Pulsating Currents Star"]

[Excerpts] It was to be expected: electro-plating deposition suing pulsating currents starred at the last SITS [Surface Treatments Exhibition] where several rectifier manufacturers had selected this subject as the main attraction at their booth. From the standpoint of visitors, the interest in this technique which may be used to obtain denser, better distributed and shiny deposits without the need for brilliance enhancers, was not less. The principle consists in feeding the electrolysis cell with pulsating currents characterized by their polarity (positive or negative), their amplitude (peak intensity), their pulse-width, and their frequency.

One of the oldest manufacturers in this field, Egatec Co, presented the PLS 3000, a generator capable of delivering pulses with a peak amplitude of 200 amps under 10 or 20 volts. The current rise-time varies between 2 and 20 microseconds depending upon the peak amplitude and the impedance of the installation. The user is able to vary the pulse frequency within a wide range. The Polar device, distributed in France by Gemdata and Pelidag, is not a rectifier, but a current chopper which is located between the conventional rectifier and the work cell. It is capable of delivering peak currents of 500 amps. The positive or negative pulses frequency may be adjusted within a 12 kHz range maximum.

There are also two newcomers on the market: Accore, with a 500 amps peak device and another of 1000 amps still under development; Solyred, a company recently created by people having left Accore, and showing an 80-amp peak rectifier (25 amps effective) under 25 volts while waiting for a 2000 amps peak device (400 amps effective) under 50 volts. Because of the use of fast MOSFET power transistors, the current rise-time may be as low as .1 microsecond, without taking into consideration the impedance of theuser's installation which may modify these rise-times.

Finally Bardon, another French manufacturer, claims to have performed some tests in customer environments and intends to offer an industrial device in the near future. Since they were introduced in France 1 or 2 years ago, pulsating currents have found applications mostly in the area of precious metals deposition for the electronics industry.

What About Cathode Pulverization?

Everybody talks about it. In spite of that, cathode pulverization was almost forgotten at the SITS. Fortunately, the Farkas Engineering Co had devoted an important part of its display to the subject. No machines, except in photographs, but many parts, especially for automobiles, were displayed: radiator covers, wheel covers, door handles, headlight trims, etc..

Farkas Engineering, representing Takamatsu Co in Europe, has provided 2 pilot installations: one at Renault, the other at Faca, a vendor located at Luce, near Chartres. These are rather smallish cells (.5 m^3), but they could lead to industrial installations. Things seem to have progressed nicely at Faca: their operation consists of two bells, 1.2 m in diameter and 2 m high, and an automatic varnishing line. Faca's markets are home appliances, automobile industry, and perfume industry. The metals used for deposition are chrome, nickel-chrome, bronze, and copper. In any case, proponants of electrolytic deposition on plastics are uneasy about cathode pulverization. A specialist of electrolytic deposition was displaying in his booth two half radiator covers treated by the two methods. He also offered visitors the use of Brillo pads. Needless to say, the varnish protecting the pulverized deposit did not resist such a barbaric abrasion test.

It remains to be seen whether that was representative of abrasion resistance. Tests performed in Japan and in France have shown that pulverized deposits resisted well when protected by a good varnish. If it is possible to draw a conclusion from this skirmish, it is that the two types of deposition will have to share applications, electrolytic deposition being best in the most demanding applications.

6445
CSO: 3102/299

NEW STEEL-MAKING METHOD TO SAVE 40 PERCENT PRIMARY ENERGY

Duesseldorf VDI NACHRICHTEN in German 24 Apr 81 p 9

[Text] To provide for future needs, the Georgsmarienwerke in Osnabrueck has started construction of a new KS steel mill using the Kloeckner steel manufacturing process, by redesigning and relocating at the Georgsmarien works the Siemens-Martin and electric arc furnaces from two locations. The Kloeckner steel manufacturing process--the result of in-house research work--makes it possible to transform scrap and other solid iron-bearing materials to steel with a significant reduction in primary energy consumption, which amounts to about 40 percent in comparison with the Siemens-Martin or electric furnaces.

Its further advantages are high flexibility in raw materials charge from scrap, crude iron and sponge iron, high productivity because of short melting time periods, and domestic energy supply by the use of fine coal as the main energy source. The quality of steel produced by the KS process is comparable to oxygen blown steel; the last part of the melting and refining phase in the KS steel mill, which determines the steel quality, corresponds to that of the oxygen blown process. Subsequently, the steel thus melted is treated in a new vacuum degassing plant in order to obtain minimum oxygen and hydrogen content. The KS plant with a charge weight of 125 metric tons replaces six Siemens-Martin furnaces. The annual production capacity of the mill is to be 1 million metric tons of high quality and refined steel, which will be processed further in Kloeckner rolling mills. A byproduct produced in the plant is coal gas, which can be used in the process and thus still further lowers the primary energy demand. Within the scope of research promotion for readily marketable products. The Federal Ministry for Research and Technology supports development of the forward-looking KS process. On 8 May 1980 the cornerstone of the KS steel mill was laid. The steel structure is now being erected; from it one can already judge the size of the new steel mill. Commissioning is scheduled for the end of 1981.

At this year's fair in Hannover the model of the new KS steel mill was exhibited in the fair pavilion of the Kloeckner-Werke AG.

5586
CSO: 3102/293

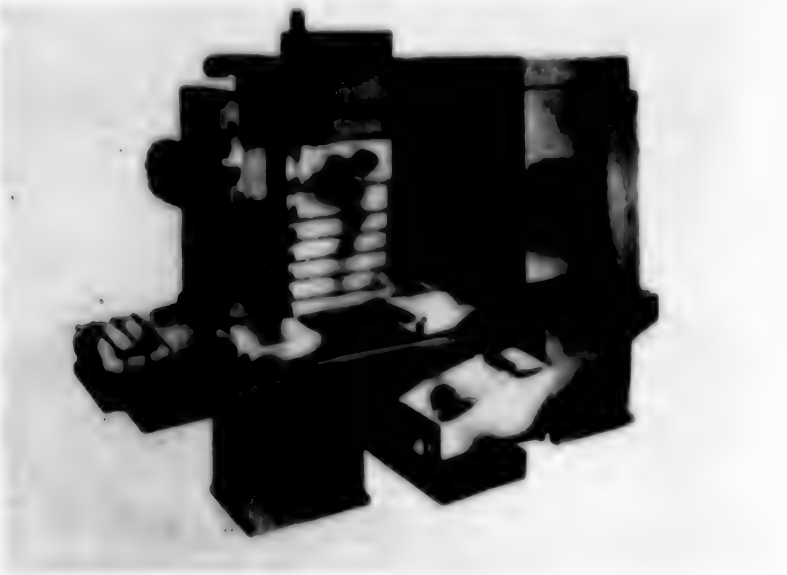
MACHINES FOR PEUGEOT FLEXIBLE WORKSHOP

Paris INDUSTRIES & TECHNIQUES in French 1 May 81 p 11

[Article: "French Milling Stations for Flexible Workshops"]

[Text] Peugeot Cycles has just ordered seven Gruffenstaden CU 100 milling stations for more than 12 million francs. They will be incorporated into a flexible production line. Parts will be conveyed by self-propelled trolleys and the whole will be completely computerized.

This order follows upon that from Renault which acquired four machines for one of its flexible workshops in 1979. Forth CU machines were sold by Graffenstaden last year.



Milling station without housing.
Parts fed by self-propelled trolleys.

11706
CSO: 3102/304

BRIEFS

RESEARCH BUDGET OUTLINED--The 1981 research budget of DM 6,139,700,000 represents an annual increase rate of 5.2 percent over the previous year, and thus falls on the curve of the average rate of increase of the total budget. Present intermediate-term financial planning requires curtailments in planned expenditures by more than DM 2 billion by 1983. This means that a number of the projects or program expansions planned originally can no longer be carried out. The 1981 budget provides a considerable increase in funds for a number of research areas. Included are coal refining processes, research and development for nuclear waste disposal, microelectronics, biotechnology and polar research. Energy research in both the nuclear and non-nuclear areas remains the highest priority, with the aim of achieving "freedom from petroleum." Equally important for shaping the future are innovations and the opening up of organic and inorganic resources. Other development areas had to accept substantial reductions. Included here, for example, are the transportation technologies, data processing and structural research. The areas of ocean research and ocean technology as well as polar research show an increase of about 6.5 percent from DM 198 million (1980) to DM 210.9 million (1981); this is slightly above the total rate of increase of the BMFT [Federal Ministry for Research and Technology]. [Text] [Duesseldorf MT MEERESTECHNIK in German Apr 81 p II] 5586

CSO: 3102/293

PRESENT, FUTURE APPLICATIONS OF TITANIUM ALLOYS IN AIRCRAFT

Paris L'AERONAUTIQUE ET L'ASTRONAUTIQUE in French No 2, 1981 pp 88-91

[Article by G. Hilaire, chief, Central Laboratory, SNIAS [French National Industrial Aerospace Company]: "Present and Future Applications of Titanium Alloys--Airframes --Helicopters--Engines"]

[Excerpts] Interest in Titanium Alloys

Titanium is attractive on three levels:
- Its specific strength--higher than that of ordinary steels and lightweight alloys, practically equal to that of high-strength steels.

Examples:
. The monobloc-forged hub-strut unit of the Lynx helicopter.
. Numerous elements of the jet engine strut assembly of the Airbus A300B.
. Bolts.
- Its temperature capability.

Examples:
. The air intake on a ramjet engine.
. Air conditioning ducts.
- Its additional properties:
. Resistance to oxidative corrosion.
. Superplasticity (and diffusion bonding capability).
. Coefficient of expansion.

Examples:
. Sphere produced by superplastic forming.
. The Mirage 2000 tail fin in which titanium is attached to carbon composite by "in-situ" bonding.

Disadvantages of Titanium Alloys

Next to considerable advantages titanium poses numerous inconveniences:

For small parts whose mass is around one kilogram, such as a bellcrank, clevis, or brace, the prices for titanium steel parts are between Fr 4500 and Fr 6000 per

kilogram, or two to three times more than what it is permissible to spend to save weight on a commercial airplane.

- Supply problems, related to the excessively small number of titanium sponge producers and to the total dependence of France on foreign sources.

- Machining, in spite of some improvements, remains very disadvantageous; its cost is about 1.5 times as high as for a steel part of the same geometry for ordinary fabrication tolerance, two times as high for close tolerances.

- Other properties, such as its poor coefficient of friction and the difficulty of preparing surfaces which are to receive adhesives or paints, in certain cases can be an obstacle to the use of titanium.

Future Perspectives

Having thus quickly sketched the pros and cons, let us try to predict developments in titanium use 5 to 10 years from now in the various sectors of aeronautics.

Subsonic Commercial Airplanes

Titanium is essentially utilized for bolts and rivets, as replacement for steel, and for certain highly stressed structural elements or mountings, for which the use of lightweight alloys or steel does not permit obtaining a correct design without excessive elimination of mass. It is also utilized for certain parts located in what are called "hot" zones as well as for linkage or stress-relief elements of composite structures.

By way of example, the percentage titanium by weight, referred to the structural mass of the airplanes, is about:
- 4 percent for the Boeing 747
- 2 percent for the future Boeing 767
- 5 percent for the Airbus.

Greater use on airplanes of this category cannot be expected. Titanium use should become stabilized at a figure in the neighborhood of 3 percent.

Supersonic Commercial Airplanes

For this type of airplane the mass criterion is much more critical than for the subsonic airplanes, and there is a substantial reduction in the performance of lightweight alloys due to the thermal effects; titanium becomes competitive and sometimes even indispensable. It is then possible to expect more extensive use of titanium in certain primary structures subjected to high levels of thermal and cumulative mechanical stresses. Thus, for a future civil transport supersonic airplane, the skin of a through-fuselage wing box and its substructure (spars, ribs) very likely will be made of titanium, with attempts to combine the techniques of superplastic forming and diffusion welding.

Execution of 10 percent of the structural mass of the airplane in titanium can be envisioned.

Helicopters

For helicopters too, the prices for titanium are prohibitive, and there is evidence that after daring trial applications on the Lynx and Puma the use of titanium will be abandoned for the reasons already enumerated, together with additional problems of fatigue resistance and difficulties of repair.

Though titanium may be retained for thermal applications (fire wallls), it will very often be replaced by composites (such as for rotor hubs) which are superior in many applications.

Conclusion

Over the next few years, in the domain of airplanes, helicopters, and missiles, excluding its application in engines, an increased utilization of titanium is not to be expected (aside from any increases related to stepped-up production).

For this state of affairs to be changed, it would be necessary to:

- Lower the prices of parts by playing upon:
. The price of the raw materials (doubtful).
. The technology of use.

By development of new techniques in:
. Powder metallurgy.
. Superplastic forming.
. Diffusion bonding.

- Augment the sources of supply:
. With a European sponge plant, or better yet, a French plant.

- Devise remedies for the technical disadvantages by spurring research which could (there is every reason to hope) permit discovery of titanium alloys of higher performance than the good old annealed and heat-treated Ti-6Al-4V (which accounts for more than half of the total U.S. production of titanium alloys). For, as certainly must be acknowledged, the range of grades and properties being offered is ridiculous by comparison to what can be found among steels, lightweight alloys, and composites.

A few efforts along these lines are in progress; however, they do not appear sufficient to tip the scales.

9828
CSO: 3102/281

'SUPERPLASTIC' TITANIUM FOR LIGHTWEIGHT A310 PARTS

Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 8 May 81 p 7

[Text] London, 7 May--The British Aerospace Public LImited Company, half of which was recently returned to private ownership, announced that it is now the first company in the world to manufacture parts from titanium for the series production of civilian aircraft, using a revolutionary new process. The new A310 version of the European Airbus will have four structural parts of titanium alloy manufactured by the "superplastic forming and diffusion bonding process" (SPFDB). Using this process the cost of the parts is said to be reduced considerably. The parts weigh less than two-thirds as much as the same parts manufactured by a conventional forming process but are equally strong.

The four parts are "boxes" which enclose the screw jacks and shafts for the moveable surfaces at the leading edge of the wing when they are retracted into the wing. The boxes also form part of the compartmentalization of the main fuel tank in the wing. They are designed to withstand high pressure. The application of the new process on these four relatively small parts alone will save 1,000 per aircraft, about DM 4,700, explained British Aerospace. In the process titanium sheets are welded all the way round at the edges to form a gastight envelope. They are heated to 950° C in the precision mold. The metal assumes "superplastic" qualities, which allow it to be blown into the desired shape against the surrounding form with extreme precision.

In its superplastic state titanium can be stretched to more than 10 times its original length. An inert gas is used for the forming stage of the process, which is not unlike glassblowing. As the gas pressure forces the titanium to flow into the desired shape, the combination of heat and pressure also causes the adjoining titanium surfaces to fuse completely with each other, as if they were molecularly one piece of metal. Technicians at British Aerospace talk about "diffusion bonding." They have spent 10 years at the Filton works developing the process to the point where it can now be used for the series production of parts. They explained that it can be applied in the same way to much larger and more complex parts. For example, structural patterns for missile wings have been manufactured in one step using this process, and many additional civil and military applications are being considered.

9581
CSO: 3102/294

AIRBUS A310 PROGRAM: CONSTRUCTION, SALES

VFW in Full Production

Gelsenkirchen AEROKURIER in German May 81 p 538

[Text] Lemwerder VFW Plant: Airbus Production in High Gear

The Airbus production being in high gear, each month now the partner companies are delivering major components for four Airbuses to the final assembly line of Airbus Industrie, Toulouse. The continuous production sequence provides for the delivery of five aircraft per month for mid-1982. The production plan provides for six aircraft per month as of February 1983, seven aircraft as of September 1983, and eight aircraft as of early 1984. In the Einswarden and Lemwerder VFW plants fuselage sections 13 and 14 are produced. This is the section between cockpit and wing. In the Bremen plant the Airbus wing is equipped with all systems and tested as to its function.

Body sections 13 and 14 built in the Einswarden plant are transported to Lemwerder by water on the company-owned "Weserflug" ferry. At present, six fuselage sections are equipped at the Lemwerder plant, including the first fuselage section 13/14 for the A310 Airbus.

All essential aircraft operating and control systems have to be installed in these fuselage sections, including operating and monitoring equipment for the engines and the auxiliary turbine in the rear, control elements for the elevator and rudder units and all movable wing parts, e.g., landing flaps, rudder, spoilers, slats. Furthermore, the fuselage section is equipped with air-conditioning, electrical systems, hydraulics and water supply for galleys and washrooms and is soundproofed and heat-insulated.

On 5 May, the A310 fuselage sections 13/14 will be flown from Lemwerder to Toulouse, where the final assembly of the first A310 will take place. In addition, the VFW plant is equipping the A310 wing with all movable parts for complete functioning; of those, the outer landing flap and the spoilers made of carbon-fiber composite are built by VFW as well.

The A310 maiden flight will take place in Toulouse in March of 1982. Following a test flight period of 1 year, the aircraft will be licensed. Delivery to the airlines will take place as of March 1983.

In all Airbus partner companies, efforts are currently underway to shift production into high gear. In the VFW Lemwerder plant, as many as six fuselage sections [see lower photograph on preceding page] are being worked on simultaneously in order to guarantee the monthly production rate of four Airbuses. If the production rate increases to eight aircraft per month within less than 3 years, ten body sections will be equipped in this plant. The fuselage section pictured in the foreground belongs to the first A310s. It will be delivered to Toulouse on May 5. The upper photograph shows the first A310 wing leaving the Chester plant of British-Aerospace.

Wardair Orders A310

Gelsenkirchen AEROKURIER in German May 81 p 538

[Text] Canada: Wardair Orders Twelve A310s

Canadian Wardair is the second North American customer to make a decision to purchase the Airbus, i.e., the A310 Airbus. Thus, Airbus Industrie was able to compete with U.S. industry on the toughest defended market. Wardair is a leading Canadian airline charter company. The contract, including an order for six additional aircraft of this type, was signed in Toronto in late March. Wardair will receive their first A310s in October and November of 1983. The remaining four aircraft are scheduled for delivery in 1984 and 1985.

Thus, Wardair will be the first airline in North America utilizing the A310. For Wardair the small Airbus will replace long-range aircraft, which can no longer be used economically in the airline's medium-range service network. Although the A310 is offered with a maximum of 282 seats, the airline chose a seating arrangement of 222 seats. Counting Wardair, 39 airlines worldwide have now chosen the Airbus models A300/A310. A total of 315 orders (232 firm orders, 83 options) have been placed for the A300, as many as 148 orders (78 firm orders, 70 options) have been placed for the A310. A few days earlier, Eastern Airlines had converted nine A300 Airbus options into firm orders (also see AEROKURIER EXPRESS 4/81, page 394) and thus increased the number of Airbuses on firm order by this airline to 34. In addition, Eastern Airlines had opted for 26 additional aircraft, thus becoming the largest Airbus customer ever.

Nigeria 40th Customer

Gelsenkirchen AEROKURIER in German May 81 p 538

[Text] 40th Airbus Customer--Nigeria Orders Four A310s

In mid-April, Nigeria Airways ordered four "small" Airbuses, type A310, from Airbus Industrie. Together with this order they opted for four additional aircraft of this type. For Airbus Industrie, Nigeria Airways is now the 40th customer to make a decision in favor of the European "big savings" jumbo jet. Delivery of the first two A310 Airbuses is scheduled for the fall of 1983. The two additional aircraft will follow in the spring of 1984. Nigeria Airways plans on utilizing the A310 for domestic flights, as well as for flights to Europe. The order from Nigeria brought the number of Airbuses ordered to a total of 469. Of those, 315 are firm orders and 154 are options.
9544
CSO: 3102/305

COMPOSITE MATERIALS SUBJECT OF INTERNATIONAL GATHERING

Paris INDUSTRIES & TECHNIQUES in French 1 May 81 p 8

[Article by G. Guyard: "Composites: OK for mass production items"]

> [Text] The participants at the 16th International Workshop on Reinforced Plastics were unanimous: expansion of uses for these materials never ceases. Mass production will be involved from now on. Automakers are leading the way, propelled by the developments in utilization techniques and the energy savings. For their part, the chemists are constantly improving their products, such as an unsaturated polyester foam or a resin polymerizable with ordinary ultraviolet lamps.

Fiber + binder = composite material. What could be simpler? But with what fibers, what binders, and for doing what, how, at what price...? The questions raised by the approximately 700 participants at the 16th International Workshop organized by the Center for Documentation of Glass Textile and Reinforced Plastics covered a vast field. Salient facts: composites are increasingly entering into automotive design, and the resin manufacturers are increasingly adapting their formulations to facilitate utilization.

In conjunction with the workshop an exhibit was assembled by some 40 companies, with two "spotlighted" products: an unsaturated polyester foam and a UV-polymerizable resin.

The transport field takes in around 25 percent of the production of glass reinforced plastics (GRP). The remainder is divided among electrical and electronic uses, sporting goods, and construction use. For that matter, out of 25 lectures delivered, 6 concerned automotive uses. To diminish fuel consumption, weight reduction is receiving high priority for research: parts without stress (such as a transmission case), working parts (such as a pedal assembly support), and the body. In body applications, the technique generally used is hot shaping of glass fabric preimpregnated with thermoset resin (SMC, sheet molding compound). That method is used for fabrication of cowls for certain Porsches (by Bayer) and for the Peugeot 505 for sale in the United States. The doors of the VERA are also manufactured in that way. But for the

automobile industry the problem has been production line speeds. A new class of materials--the stampable reinforced thermoplastics (SRT)--made their appearance in the United States. They are capable of being processed at rates of up to 80 pieces per hour, while the rate for SMC is limited to about 30. The thermoplastics employed are generally polypropylene homopolymer and nylon 6. The reinforcement consists of continuous glass fibers. Thus very high thermal and mechanical properties are obtained even on pieces with a 250-mm stamping depth. Furthermore, there are no fins (burrs) to remove, and the scraps and rejects can be recycled. Housing produced by that method resist temperatures between -30 and +130°C, or even higher. The only drawback of this technique: the surface obtained is "grainy." A smooth appearance thus cannot be obtained. But this drawback is minor compared to the number of possible applications: battery supports, noise-reduction shields, rocker arm covers, window lifters, etc. In addition, it is possible to line the die to obtain a finished part in one operation: some rear window ledges and some seats are already being fabricated with SRT.

Carbon fibers are also finding use in automobiles. Given their cost and their performance, it is better to use them for parts which must simultaneously satisfy various requirements: lightness, damping of vibrations, and fatigue resistance for a propeller shaft; good coefficient of friction, hot oil resistance, and fabrication in a single operation for a gearshift fork. But up to now the only effectively utilized mass production part is a distributor part made of carbon fiber reinforced nylon whose resistance to friction and fatigue is clearly improved. However, even if capacities for fiber production increase rapidly (5,000 tons/year expected by 1985), it is quite out of the question to fabricate carbon reinforced body components.

UV-polymerizable unsaturated polyester resins have been around since 1977. In spite of their advantages (ready to use, fast curing), their development has been limited by the fact that the only suitable UV source has been high-pressure mercury vapor lamps, which consume a lot of energy and are not very practical to use (protective screens required, vapor aspiration hazards, etc). BASF has developed systems of modified resins used in association with new activator systems capable of polymerization using ordinary UV lamps (wavelength between 350 and 420 micrometers [sic; more likely nanometers]). Their shelf life in the absence of light is better than 6 months. The laminates may be up to 10 mm thick. The rapidity of the polymerization enables some tubes to be fabricated at a rate of 120 meters/hour. Up to now the preparation of expanded unsaturated polyesters has not been very thoroughly perfected; the density and the size of the cells have tended to be irregular. A small company, Resiland S.A., has developed a series of self-supporting rigid foams with gradations of density between 120 and 600 kg/m^3.

The parameters are perfectly controlled: dimensions and wall thicknesses of the cells, compressive strength, and thermal and sound properties. Various kinds of surface finish can be used: SMC or hot-sprayed metallic coating!

9828
CSO: 3102/303

NEW TECHNOLOGY FOR HIGH-SPEED TRAINS EXHIBITED

Duesseldorf VDI NACHRICHTEN in German 24 Apr 81 p 24

[Text] At this year's Hanover Industrial Fair the Thyssen exhibit "Importance of Wheel-to-Rail (R/S) Research for Future Rail Transportation" attracted many experts in the railroad field. For the first time details were available about the new bogie for the Experimental Vehicle I, which is being developed under the R/S research program for speeds up to 350 km/hour. It is a running and steering bogie with an H-form frame. The center cross support is divided, because the middle of the bogie is to be kept clear for experimental purposes. For the same reason the traction pivot has been shifted from the bogie center. The wheel sets are suspended on coil springs and located by triangular arms. By changing the locating arms the elasticity of wheel set location can be altered within certain limits and in a short time. Air springs suspend the carriage vertically and laterally.

The R/S bogie for the first experimental vehicle is equipped with a stabilizer link and a hydraulic swiveling damper. Each wheel set has two disc brakes. In addition the brake equipment of each bogie includes: a magnetic rail brake and a hand brake. In the "integrated traction bogie" for the future high-speed vehicle the disc brake system with three brake discs is an integral part of the tubular shaft drive. The brake discs are also supposed to contribute to directional stability. The experimental test bogies will be tried out this year under the Henschel diesel locomotive with DC electric transmission (DE 2500).

According to Henschel's chief designer, Dr Hans Dieter Eisbrecher, the immediate goal of development is to reach a high speed and at the same time to ensure the suitability of traditional lines, which in part contain tight-radius curves. After the test runs have been completed, the foundation will have been laid for the construction of a traction bogie that can fulfill all the requirements of future rail transportation.

Concerning higher roadbed requirements, it was reported that Thyssen, as the first rail manufacturer in the world, has recently acquired the capability of delivering rails 60 meters long (previously 30 meters). These rails, with a durability of 1,400 Nmm^2, are currently being tested in heavy-load traffic. The manufacture of 60-meter long rails became possible after the production plant was converted to two-heat rolling using continuous cast starting material.

In cooperation with the Technical University in Munich the theoretical and practical bases were worked out for a new steel tie which is intended for use on highly stressed primary tracks. Compared with earlier versions, this new roadbed element is considerably lighter, even though it has a greater load capacity. Concerning the calculations for the new tie, Dr Hans Schmedders said that primary tracks must be suitable for static axle loads of 250 kN; this upward jump, from the normal German Railways (DB) 220 kN to 250 kN, was substantial and was a good argument for not simply extrapolating proven forms. By subjecting all known steel tie forms to examination an optimal shape could be found on the basis of reliable static and dynamic calculations. The tie meets both the axle load ranges issued by the DB and the technical requirements for rolling, bending and bedding. Influences from rail fastening technology and electrical insulation were taken into account. The trapezoidal steel tie is also being tested on high-speed lines of the DB and in heavy-load traffic in a soft coal plant.

9581
CSO: 3102/294

INNOVATIVE FEATURES CHARACTERIZE FRENCH HIGH-SPEED TRAIN

Paris SCIENCES & AVENIR in French May 81 pp 84-88

[Article by Pierre de Latil: "TGV: The Physics of High Speed"]

[Text] Travelling at 380 km/h, the TGV (high-speed train) has just established a world record: this is the fruit of lengthy fundamental research work.

In breaking the rail speed world records last February, the TGV brilliantly proved that French engineers have acquired perfect mastery of high railway speeds. The TGV is perfectly at ease above 350 km/h; does this mean that it will travel long distances at such speeds? No, because above 300 km/h, air resistance requires too great an expenditure of energy; a 260 km/h limit will therefore prevail on the Paris-Lyon run, for an average of 215 km/h station-to-station.

At such speeds, aerodynamic problems become very important. That is why the train is completely faired, with hardly a gap between cars, and with an undercarriage structure which is a totally new and crucial element. The overall fairing is broken only on the sides to provide a direct view of wheels and bogies, for sight inspection and access to mechanical parts.

For the undercarriage aerodynamics, it should be noted that the ground effect which tends to lift the vehicle at high speeds and to reduce the adherence of formulas 1, practically does not occur in in rail operation: the TGV becomes lighter by only one-half ton at high speeds.

The Thorny Problem of Adherence

But train aerodynamics are very special: they must be reversible. This means that since there can be no question of maneuvering the trains at terminals, they must be designed to offer minimal resistance in both directions. The front of the leading locomotive must provide maximum penetration, while the rear locomotive must be shaped so as to best avoid shockwaves which might create suction. The matching shape at both ends must therefore be a compromise between different requirements.

Aerodynamics made great progress with the TGV's reduced "master-couple", namely the surface presented by the train in the forward direction. Until now, this front cross section had not been the subject of any special research; roughly speaking, it

The TGV, the world's fastest train, will connect Paris to Lyon in two hours at an average speed of 260 km/h. Thanks to its excellent aerodynamics, it will consume no more power than the Mistral. This speed will be reached with complete safety, as demonstrated by the recent performance of the TGV, which reached 380 km/h, beating the world speed record that was already held by SNCF since 1955.

An entirely new type of bogies was designed for the TGV in order to avoid railbed deformation at very high speeds; lighter, larger, and equipped with an entirely new transmission system, they are equally remarkable because of their mounting position between two cars. This median position has led to the construction of a new articulation device for cars, or "intertraffic band", which improves the train's comfort through its flexibility and airtightness.

was that of a rectangular body covered by a rounded roof. The new body with several slant panels clearly fits within the cross section of the newest cars. The height of the body is thus definitely reduced: 3.42 m above the rails, compared to 4.05 m, or a reduction of 15.3 percent. This, as we will see, is related to the new bogie design.

One important factor in forward motion resistance, especially at these speeds and especially for a 200 m-long train, is the wetted surface, or the surface covered by the slip stream: here, the perimeter of this surface is reduced by about 12 percent. Thus, J.-C. Boutonnet, chief engineer at SNCF, who served as our instructor aboard the TGV and later in his office, concluded: "Studies bearing on TGV aerodynamics will make it possible to consume no more energy at a speed of 260 km/h than the Mistral uses now: 7500 kW/h or 19 kW/h per available seat on the Paris-Lyon run."

Before discussing rolling, we must recall some familiar data: the moving force--or braking power--develops thanks to the adherence of the wheels to the tracks. This adherence can be roughly defined as the friction of the moving vehicle on the rolling surface: it is formulated by the ratio between traction power (or holding power for braking) and weight, T/P. In reality, things become much more complicated, because in the case of a very heavy vehicle, contact surfaces are distorted and a small relative slippage must be taken into account.

But adherence characteristics cannot be defined statistically, because the track is more or less affected by humidity, grease particles, leaves, pollen, and so on. Therefore one speaks of "statistically available adherence."

Consequently, when approaching a new range of railway speeds, it became necessary to conduct tests under operational conditions. That is why SNCF carried out numerous test runs at various speeds, not only on well cleaned tracks, but also on tracks which were doused with detergents of well known characteristics.

We discussed these matters with J.-M. Metzler, chief engineer in charge of TGV equipment, who said: "It is a truism that adherence drops with speed. About ten years ago, when this question was being considered with the 001 experimental gas turbine train which was not catenary-powered, it was thought that reduced adherence would create problems at the speeds planned for the TGV. But tests have proven that even at 300-350 km/h, adherence remains quite adequate."

It was thus shown that at very high speeds the adherence coefficient lies between 0.19 and 0.29 on a dry track, and remains above 0.05 after dousing with a detergent. It is possible in practice to send 520 kW of power to each axle at 260 km/h. During the test of the TGV 100, which won the world record, each motor was even able to deliver up to 830 kW, granting that the adherence conditions that day were most favorable.

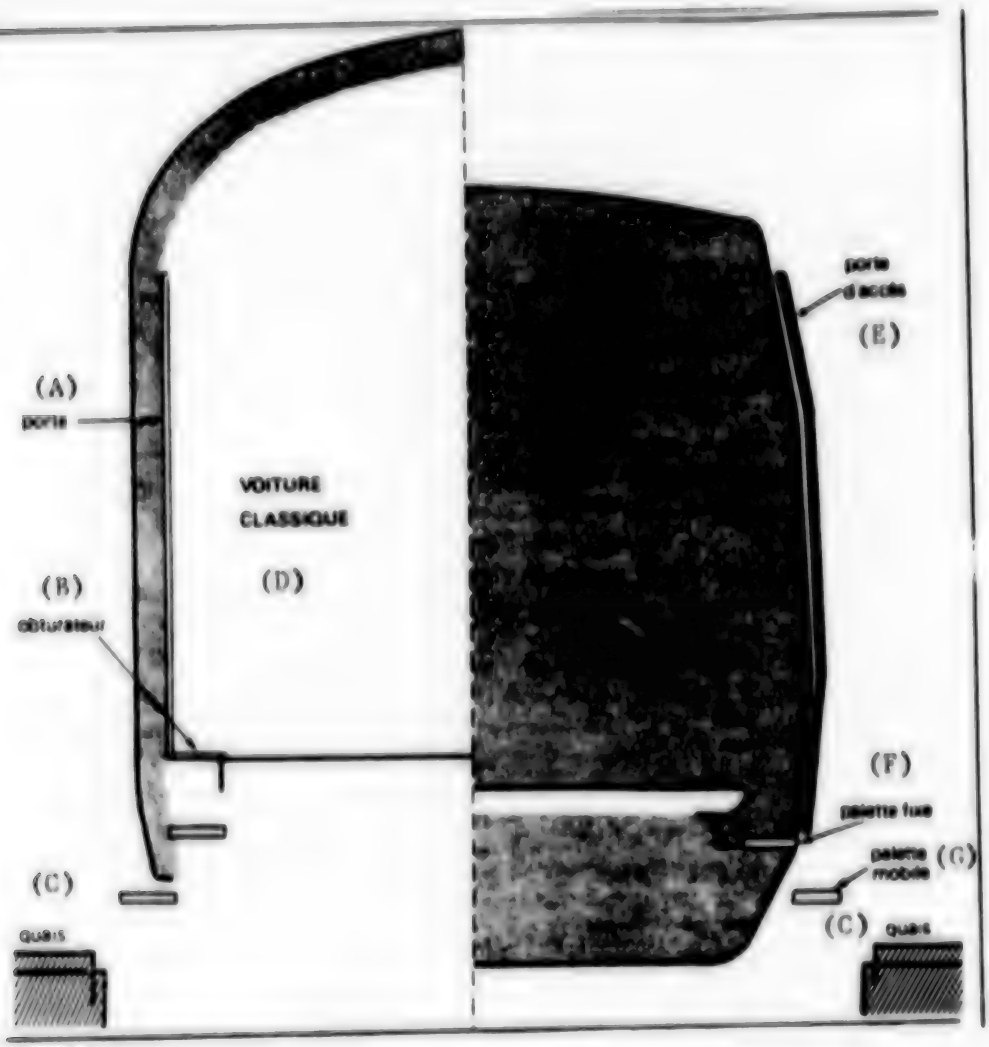
But these questions of adherence become even more important for braking; at that point they even become vital: braking forces must not exceed experimentally known adherence limits.

Tests have shown that an adherence coefficient of 0.05 is acceptable for braking. Since 0.05 is the figure that emerges from experiments with deliberately lubricated tracks, it is clear that we will always remain within safety limits.

High-Speed Instability

How does a train behave on the rails? It has been known for a long time that the best smoothing of the uneven spots which any railbed inevitably contains, is obtained by mounting the wheels on bogies, two-axle frames supporting the vehicle body on a central pivot. But these assemblies, whose principles are very conventional, have changed considerably, and now SNCF has revolutionized them to meet the new range of speeds.

As a first approximation, high speeds have little influence on vertical oscillations; in other words, there was no danger that passengers would be unduly shaken. But there was still the problem of transversal motion to be solved, of rocking and rolling, that is, of rotation in a transversal plane; and the problem of



The bogies developed for the TGV have made it possible to lower the level of the cars, with two consequences: better train aerodynamics on one hand, and on the other hand better car access, which will be further improved by the raising of platforms. The impression of comfort for travellers should contribute to TGV's success over intermediate distances, where it will be competing against airplanes.

Key: (A) Door
(B) Shutter
(C) Platform
(D) Conventional car
(E) Access door
(F) Fixed step
(G) Moving step

"lacing", that is, of rotation in a horizontal plane. At first, standards for accelerations within the cars are set within limits that are not to be exceeded; for example, no accelerations above 0.10 g in the vertical plane, and none above 0.15 g in the horizontal plane. In practice, when moving at 300 km/h, the TGV exhibited a very remarkable stability: 0.05 g vertical and 0.09 g horizontal. But it should be added that these very remarkable performances occured on absolutely new tracks.

All of this is for passenger comfort, and is achieved by suspensions which decouple the body of the car from the bogies. The bogies, located ahead of the shock absorption, become subject to quite a few more constraints: transversal accelerations of the bogie chassis can reach 0.20 to 0.80 g. Therein lies the whole question of stability, because there is more at stake than passenger comfort: it is a matter of the fatigue which can eventually affect essential mechanical elements.

In fact, in the new range of speeds, this problem has proven to be infinitely more serious than had been supposed: from 270 km/h upward, oscillations begin to occur, and they go on increasing with higher speeds, raising the question of fundamental instability. And it was not surprising that during the 1955 world record, the rails subjected to such oscillations underwent displacements of several centimeters.

One Bogie for Two Cars

In order to fully appreciate the importance of this, it must be understood that a bogie would not resist for very long against repeated oscillations of 1 g, and that it would be difficult to lay down tracks solid enough to withstand such lateral stresses.

Naturally, laboratory tests were systematically conducted to analyze the causes of this instability in the bogies, and to check the accuracy of the proposed mathematical models, in order to account for the phenomenon.

Lastly, practical solutions were advanced which made it possible to reduce these dangerous oscillations below design limits. These approaches were two-fold: 1) reduce the weight of the bogies; and 2) increase the wheelbase, that is, the distance between the two pairs of wheels.

How to reduce weight? There was no question of skimping on the thickness of the steel used in wheels and axles. The only solution was to eliminate the electric motor from the driving bogies, the heaviest ones by definition, and to tranfer the motor to the vehicle itself.

This is what was done, and this is what represents one of the most revolutionary technical features of the TGV. But this posed a very serious problem: the rotating motion of the motor had to be transmitted to the wheels while the car and the motor moved constantly with respect to the wheels. The problem was solved with a telescopic shaft named "tripod", so called because the rotary motion is transmitted by a triple part sliding in a cylinder.

The other mechanical requirement imposed by the fight against vibrations was apparently easier to satisfy: to increase the distance between the two wheels and bring it from the traditional 2.5 m to 3 m.

But this obligation led to a reconsideration of the whole train architecture. Since it was difficult to place two enormous bogies under each car, the following suggestion was adopted: one bogie shared by two cars. This is the concept of the articulated train.

This arrangement, in addition to providing a better distribution of the load per axle along the train, offers many other advantages (lower weight, less resistance in the forward direction, lower passenger floor, better interior traffic, and particularly effective soundproofing). In addition, the general lowering of the train places the passengers at a greater distance from the wheels, which are a major source of noise. As a result, the length of the cars must be reduced, the pivot point on the bogies being moved to the extremities, unlike conventional vehicles which have a 3 or 4 meter overhang beyond the bogies.

This lowering of the floor level to 1.02 m from the 1.25 m of conventional trains, makes access much easier for passengers, and the elderly in particular, especially since SNCF determined to exploit this improvement to the fullest; they have decided to increase to 55 cm the height of platforms at which TGV's pull in. The cars can thus be entered effortlessly on two steps, one of which is telescopic. The platforms will be systematically raised at stations where the new trains will stop.

Everything thus contributes to an impression of ease in trains which, completely shut off from the environment, will not open to the outside, and will inevitably suggest the planes with which they are meant to compete over intermediate distances. For once, speed and comfort will be compatible.

The TGV and Europe

Connecting the three largest French cities, the Sud-Est line is the most heavily travelled of all SNCF routes. It carries a traffic of 250 trains per day, and 300 at peak periods; it therefore has four tracks.

However, it was not possible to widen the original railbed right of way at two sections. Two tracks had to be kept as they were: 85 km between Saint-Florentin and Les Laumes, and 25 km between Blaizy and Dijon (Seuil de Bourgogne). Over these sections, the tracks are "banalized", which means that they can be used for trains moving in either direction. This was made possible by signal and block systems that are matchless anywhere in the world.

Unfortunately, these congestion points are often saturated, forcing the interruption of freight traffic, which has led to studies for breaking up these deadlocks. Widening all four tracks in Bourgogne would cost 1.4 billion francs, or 40 percent of the TGV track project.

Understandably under these conditions, the TGV solution became imperative, especially since one of its principal advantages is to free the old track where freight traffic will be able to move unimpeded.

The success of the TGV immediately suggests a possible extension of this method to a European network. Those familiar with the long range projects being considered by the International Union of Railways, even have a name for these trains: the Europolitains. A network of major main lines has even been established, with plans for 5800 km of new track laid for speeds of 250-300 km/h.

It thus becomes clear that the TGV technique will have to directly apply to this European network, whose initial link could be a Paris-Brussels-Cologne connection. And it is impossible not to consider that France and its industry will renew, in the railway sector, the same proposals on which was based the triumphant Airbus program: the construction of the new trains would be shared by the industries of the various countries.

PHOTO CAPTION

One of the major problems raised by high speeds is to maintain sufficient wheel adherence to the rails at the moment of braking. SNCF has undertaken tests on dry tracks and on tracks deliberately coated with lubricants. These experiments have demonstrated that the TGV's adherence coefficient remained far above safety limits, even at speeds higher than 350 km/h.

11,023
CSO: 3102/292

'CLEAN' PISTON INTERESTS AUTO MANUFACTURERS

Paris LE FIGARO in French 2 Jun 81 p 13

[Article by Jacques Chevalier: "The Miraculous Piston Which Is Interesting Manufacturers"]

[Text] Although the struggle to save energy has attracted some Charlatans promising the earth and a garden patch around it with fake gasoline savers, it has also led study offices and serious technicians to have second thoughts about the automobile of the eighties. A combination of "tricks" has enabled spectacular results to be obtained, as with the Peugeot Vera prototype (see our edition of 23 May). It is not a matter of a revolution, but of judicious and complete adaptation of the mechanical operation. In the same way a French inventor believes that he has invented a "clean" piston which, according to him, makes it possible to double the life of an engine and reduce its full consumption. This piston is being studied in France, Germany, and Italy but the large manufacturers have not yet rendered their verdict.

Mr Promeyrat's idea is simple but before explaining it briefly several elementary principles must be reviewed. As is well known the piston of an engine is given a reciprocating motion within a cylinder. In rising the top of the piston compresses the gaseous mixture which, under pressure, tends to leak. The closed valves, above, seal it. Below, they penetrate between the cylinder wall and the piston between which there is clearance in order to permit movement.

So the expedient of installing a metallic ring around the entire circumference of the piston was adopted which, in contact with the cylinder wall, should block such gases. At the same time it prevents oil creeping from below into the combustion chamber. This "piston ring" undergoes such stresses that it nevertheless allows a small portion of the gases to get past. They are finally stopped by a second piston ring, a little lower.

Unfortunately carbon deposits destroy or impair proper functioning. In fact, these combustion residues and carbonized lubricants, which attain a stony hardness, deposit progressively behind the first piston ring, called the "combustion seal," because it sustains the explosion of the carbureted mixture. By accumulating, at 40,000 or 50,000 km the carbon deposits finally force the piston ring against the cylinder, causing a drag on the piston and loss of power. In the end there is blockage.

The TNM* process prevents this self-same blockage to which, according to Promeyrat, no study bureau has ever devoted any attention. "My invention is simple," he said, "and it is adaptable to any reciprocating piston engine. It consists of cutting several grooves ahead of the combustion seal ring. These will take up a portion of the gases and decrease the pressure upon the ring without affecting the power. Within each groove there is placed a free-floating ring of compound wire on the fashion of a piano string and whose movement should prevent carbon deposits."

The result, according to Promeyrat, is that the piston rings remain clean and the engine becomes more and more efficient the more kilometers it goes. Its useful life should be doubled and its "appetite" not increase with age; the difference can exceed 20 percent for engines which have run 100,000 km and more. To that must be added appreciable gain in flexibility, quietness, and lubricant economy, and a 50-percent reduction in gaseous pollutants noted.

Credible long run experiments are said to have accentuated improvements consistent with Promeyrat's claims. However, only the manufacturers can settle the question definitely. In the meantime the inventor is marketing his "Godsend." Cost to modify an engine: about 2,500 francs.

11706
CSO: 3102/304

*TNM Etablissements Promeyrat
17 Rue Ernest-Savart
93100-Montreuil Telephone: 858-75-37

PILOT PLANTS FOR CARBUROL PRODUCTION PLANNED

Paris INFORMATIONS CHIMIE in French Apr 81 pp 113-114

[Article: "Carburol: Pilot Units Set Up Beginning This Year"]

[Text] Last week during a trip to southwest France, Andre Giraud provided details about the development of the Carburol Program and announced the establishment of a number of pilot units, including in particular a unit for producing fuel from agricultural by-products in Soustons, in the Landes. The Carburol Program, approved 14 January by the Council of Ministers, is thus entering its implementation phase. Let us recall that its first stage calls for a gradual introduction of substitute fuels (10 percent in premium gasoline) without modifying present vehicles--Fr 12 million will be allocated to tests involving 500 vehicles which will be driven more than 6 million kilometers--and includes a program of tests, research, and technological development which should be brought to the industrial stage as soon as possible.

These investigations are oriented along four approaches:

1. Manufacture of methanol, which can be done using various combustible starting materials (wood, coal, gas, lignite, heavy petroleum residuums, oil shales, etc.), in two steps: production of a gas in a gas generation plant followed by transformation of this gas into methanol by passage over a catalyst (an IFP [French Petroleum Institute] process can also produce "heavy methanol," a mixture of methanol and higher alcohols which exhibits better compatibility with gasoline).

2. Production of "butyl acetone" mixtures (butanol/acetone/ethanol in a 6/3/1 ratio) from a variety of plant materials (straw, corn, jerusalem artichoke, sugar beet, sugar cane, fodder crops such as alfalfa, etc.) by a process of hydrolysis and fermentation. The fuel-related properties of these mixtures have been demonstrated by the IFP: miscibility in all proportions in the traditional fuels, "third solvent" properties (helping to improve the miscibility of traditional alcohols) and potential possibilities for mixing with diesel fuel (for use in diesel engines), possibilities which the alcohols do not possess.

These first two approaches are intended to form the basic framework of the Carburol Program.

3. Manufacture of ethyl alcohol by fermentation of sugars or starches, which in comparison to the first two approaches shows various disadvantages: the production

of sugars of agricultural origin is costly in terms of energy, and ethanol does not possess the remarkable properties of the butyl acetone mixture.

4. Manufacture of synthetic gasoline from coal or gas, which in the case of France does not stand up well in an economic comparison with the other approaches; it is thus not being pursued at this stage of the program.

At the end of this first phase, that is, around 1984-1985 at the latest, approximately 1.5 million tons of carburols ought to have been introduced into the fuel supply. Very likely these carburols will initially be of fossil derivation for the most part (coal, gas, heavy petroleum residuums); the biomass approaches, requiring a longer lead time for technological and industrial development, should be providing initial production by that time. In a second phase, a special mixture with a higher carburol content, between 25 and 50 percent, is to be brought into production and delivered through a special distribution network for use in specially modified cars.

The program planned for 1981 represents an investment of Fr 150 to 200 million in various pilot installations and certain types of research with longer-term horizons.

The first pilot unit, which will be set up in Soustons, in the Landes, falls in line with the decision to develop alternative types of energy from biomass in the Aquitaine region. The plant represents Fr 37 million in investments and will make it possible to perfect the enzymatic hydrolysis technique. This pilot plant will be capable of operating on cornstalks, straw, and fodder crops (and cellulose in general). Its start-up is planned for 1983, with a capacity of 1 ton/day. This unit will include equipment for: hydrolysis of the charge pretreated with the enzyme solution, shredding of the charge, pretreatment of the charge with steam, culture of the enzyme-producing fungus, butyl acetone fermentation proper, and distillation.

The plant will be available to the research community as a tool for experimentation in biotechnology, supplementing the experimental pilot plant for acid hydrolysis of wood which has just been built in Tarnos near Soustons by Bertin-ELF [French Gasoline and Lubricants Company]-Aquitaine in partnership, following a course of action initiated earlier by the Delegation for Innovation and Technology; the latter plant will produce "fermentable juices" capable of being treated in Soustons and in various laboratories (Solaize in particular).

Giraud also announced the building of a pilot plant for production of butyl acetone mixtures from jerusalem artichoke at an estimated cost of Fr 50 million.

The 10-ton/day unit, which will go into production at the end of 1982 or beginning of 1983, is intended to test, on a reduced scale, the feasibility of building an industrial-scale unit.

Another three installations are under study, including a pilot plant for gasification of wood with oxygen, and a heavy methanol pilot to permit preindustrial-scale testing of the IFP process for converting methanol to a mixture of higher alcohols (15-25 percent) and methanol (85-75 percent).

The latter process uses a new catalyst from the same family as the catalysts for low-pressure methanol synthesis and works under approximately the same conditions. The preparation of samples representative of an industrial production is presently in progress at the Salindres plant in cooperation with Procatalyse.

Although all over the world people are thinking about adding alcohols (particularly methanol) to gasoline, this new IFP process assumes particular interest in that it allows manufacture of higher alcohols which, added to methanol, would help solve the well-known demixing problems. The market outlook for this process is therefore complementary to that for methanol, and in the future that should mean some very large production units, since their capacity will be directly linked to that of the methanol synthesis plants (several thousand tons per day).

It is expected that one or two operational units designed for producing 170,000 tons/year from wood will go into production by 1985.

Finally, the last installation planned is an experimental platform for studying gasification of coal and heavy petroleum residuums. The documentation studied by the French Coal Board for establishing a methanol plant in Lorraine is already far along; it bears on the technical and economic feasibility of a unit for producing 500,000 tons per year of methanol from 1 million tons of Lorraine coal, which could be built on the Carling platform for an investment of some Fr 1.5 billion. But parallel studies are being conducted on coal gasification and, in particular, on the feasibility of installing an industrial-scale plant on a coastal site to process imported coal. The examination will be performed at the same time as for the program of coal gasification for purposes other than the production of methanol.

Nevertheless, the launching of these pilot units should not mask the fact that important research forms an integral part of the program, research of two types: one devoted to the mobilization of resources, the other to the methods for transformation of biomass by the thermochemical route (notably gasification) or biological route: enzymatic hydrolysis and cell lysis, which will be studied particularly using the Soustons biotechnological platform, touching upon analyses of strains for production of cellulose [sic; more likely cellulase] and the study of possibilities for mixed strains permitting simultaneous enzymatic hydrolysis and fermentation.

9828
CSO: 3102/300

BRIEFS

A 320 PROGRAM UNDER CONSIDERATION--After the Airbus A300 and A310 the "little Airbus" is now taking shape at Airbus Industrie; until now it has been under development as project SA1/SA2 and it will now immediately bear the designation A320. As the A320 appears today, it will be built in two versions, the A320-100 for 130 passengers and the A320-200 for 160 passengers. The civil airline companies around the world are definitely showing strong interest in an aircraft in this class. In Europe Air France, more than any other, is "beckoning" with an order which may be as large as 50 aircraft. The A320 would be powered by two CFM56 engines, the same as those used in its competitor, the 737-300. The A320 is primarily intended as a replacement for older Boeing 727 models and is meant, as far as possible, to be compatible with the Airbus models in the A300/A310 family in the systems. Before commencement of the A320 program the governments of the countries participating in the Airbus program will have to give their consent. In this event it is doubtful whether the A320 would be assembled in Toulouse. England would be extremely interested in this, while the interest of the German Airbus partner is described as cautious. There is also discussion about increasing the number of partner countries involved in the Airbus program; the Netherlands, Japan and Italy are conducting talks and/or would be possible partners. [Text] [Gelsenkirchen AEROKURIER in German Apr 81 p 388] 9581

MDF-100 TO COMPETE WITH A-320--The Dutch have chosen America: even though Fokker had on several occasions displayed a great interest in enlarging the Airbus family, the company has just concluded an agreemtnt with McDonnell Douglas for sharing equally in the development and construction of a 150-seat medium-range aircraft designated the "MDF-100"--an aircraft which, whatever the circumstances (no technical characteristics having yet been announced), will be competing with the Airbus A-320, if the latter even makes it onto the scene. It should be noted that, taking into account the cost of this project, Fokker and McDonnell Douglas are prepared to consider the participation of other manufacturers. The fact remains that the Dutch company will not participate financially in the development of the next Airbus. Specifically, this skeleton agreement, which should lead to the design and building of the aircraft as soon as a sufficinnt number of firm orders have been booked by the manufacturers, includes the following points: a) the cost of the program is expected to be Fr 10 billion; b) three types of jet engines are planned: the General Electric -SNECMA [French National Aircraft Engine Company] CFM 56-X, the Rolly-Royce-Japan RJ-500, and a Pratt & Whitney engine; c) plans call for the MDF-100 to go into service in 1986. [Text] [Paris AVIATION MAGAZINE INTERNATIONAL in French 15 May 81 p 13] 9828

SUBSTITUTE FUELS PROGRAM--On 22 April, Minister of Industry Andre Giraud told the Council of Ministers that following the guidelines set by the government on 14 January 1981 (1), a major program for research, development, and testing has been defined and is committed to demonstrating the performance and competitiveness of the various production methods for substitute fuels. Industrialists and researchers concerned, as well as agriculture and consumer representatives, are closely collaborating on this program which amounts to over 150 million francs as of 1981. For production which relies on agricultural products, initial pre-industrial test centers will go into operation in 1981 and 1982 in several regions of France, notably Landes; these centers will process vegetable matter based on such products as fodder, wood, Jerusalem artichokes, and straw. Other methods are being simultaneously explored, particularly methanol production from coal: for coal from Lorraine, a plant competitiveness study has been requested from Charbonnages de France. Finally, tests for the various substitute fuels have started on automobiles. As of this year, nearly 500 vehicles will cover over 6 million km to this purpose, in order to assure users of satisfactory quality. [Text] [Paris AFP SCIENCES in French 23 Apr 81 p 22] 11,023

CSO: 3102/292

END

END OF

FICHE

DATE FILMED

July 9, 1981